ISSUES AND CHALLENGES TOWARD A SUSTAINABLE DAM MANAGEMENT SYSTEM IN SELANGOR, MALAYSIA

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PREAMBLE

Water resources remains a prime concern for Malaysia as in the past, at present and more significant in the future. Population increase and the subsequent impact of urbanization, industrialization, settlement expansion and infrastructural growth makes Sustainable Dam Management System a challenging task to achieve, especially in rapidly developing state like Selangor.

ABSTRACT

The challenges in Water Resources Development are to meet the demand of society, agriculture, industry and energy use. Dams are built to provide for the increase in societal needs for water resources. Whenever the weather is hot, the water level of the dam becames a hot topic discussed in the media. This is due to water disruptions or leakage in the cycle of water resources in the state. This leakage occurs because development causes two threats to watersheds, in either the river or the dam. The first threat is in the reduction of the size of the catchment area and at the same time there are also increases in the demand and use of water resources. Due to development these threats make water resources become scarce. The need for water resources becomes more chronic in the event of hot weather. These two factors make the dam an important entity and source of water supply in Selangor, since all Selangor rivers are exposed to various threats of pollution and development. However the rapid development of the State is a major challenge in the management of existing dams. The existing dam management focuses on the management structure of the dam only. This study provide a better understand of the role of dams in water resources development planning in Malaysia and what would constitute a sustainable dam management system. In order to realize these aims the study examines the issues and challenges affecting dam management in the state of Selangor as it is the most rapidly developing state in Malaysia where the demand for water resources is at a very critical cross road. This research examined the main characteristics of dams, to assessed the issues in the dam basin, examined the existing dam management system, evaluated the dam management effectiveness and proposed a sustainable dam management system for Selangor. The research involved a site visit, interviews, review of documents and official writings and a revised map of the study area. The analysis carried out in this study is the map analysis area, analysis of the role and functions, document analysis and SWOC analysis. Major issues in Selangor dam management are related to human activities and the impact from urban sprawl surrounding the Kuala Lumpur and Selangor area. The urbanization in Selangor started approaching the dam basin area. Dam basin are also vulnerable to land use conflict, and other threats such as illegal dumping, angler, land clearing, and other's. The challenges in existing dam management system in Selangor involves the weakness in enforcement, the conflicting laws and regulations in land use control, no integration between related agencies, budget allocation issues, lack of expertise in dam management systems, lack of laws, regulation, guidelines, manual, strategic plan, and the lack of public awareness. Towards a sustainable dam management system, Selangor needs to take action with a special act for the security of dams, improvement and enforcement of guidelines, prepare a strategic plan, implement land use control, encourage collaboration between agencies and to increase public awareness about the dam basin and water resources conservation.

ABSTRAK

Cabaran terbesar dalam sumber air adalah untuk memenuhi permintaan masyarakat, pertanian, industri dan penggunaan tenaga. Empangan telah dibina untuk menyediakan peningkatan dalam keperluan masyarakat untuk sumber air. Setiap kali berlaku cuaca panas, aras air empangan menjadi topik hangat dalam media masa dan juga di bibir pemimpin. Perkara ini berlaku kerana wujudnya gangguan atau ketirisan dalam kitaran sumber air di negeri Selangor. Ketirisan ini terjadi kerana pembangunan memberi dua ancaman kepada kawasan tadahan air samada di Sungai mahupun empangan. Ancaman pertama adalah mengurangkan keluasan kawasan tadahan air dan pada masa yang sama pembangunan meningkatkan jumlah permintaan dan kegunaan sumber air. Ancaman ini menjadikan sumber air menjadi terhad. Permintaan sumber air menjadi lebih kronik apabila berlaku cuaca panas. Dua faktor ini menjadikan empangan sebagai satu entiti yang penting sebagai sumber bekalan air selepas sungai di Selangor terdedah dengan pelbagai pencemaran dan juga ancaman pembangunan. Namun pembangunan yang pesat di Negeri Selangor menjadi cabaran besar kepada pengurusan empangan sediada. Pengurusan empangan sedia ada hanya memberi fokus kepada pengurusan struktur empangan sahaja. Kajian ini diharapkan dapat membantu kita untuk lebih memahami tentang peranan empangan dalam perancangan pembangunan sumber air di Malaysia dan tindakan – tindakan yang perlu diambil kearah melaksanakan sistem pengurusan empangan mampan. Bagi mencapai matlamat tersebut, kajian ini akan mengkaji isu dan cabaran yang memberi kesan kepada sistem pengurusan empangan di Selangor yang merupakan negeri yang mempunyai kadar pembangunan tertinggi di Malaysia. kajian ini akan mengkaji karektoristik utama empangan, mengenalpasti isu yang berlaku dalam kawasan empangan, mengkaji struktur pengurusan empangan sediada, menilai keberkesanan pengurusan empangan sedia ada dan mencadangkan sistem pengurusan empangan mampan khas untuk negeri Selangor. Kaedah kajian yang terlibat adalah

lawatan tapak, sesi temuduga, semakan dokumen dan penulisan rasmi dan semakan peta kawasan kajian. Analisis yang dijalankan dalam kajian ini adalah analisis tapak, analisis peta kawasan tahun 2012, analisis peranan dan fungsi, analisis dokumen dan analisis SWOC. Isu-isu utama dalam empangan Selangor adalah berkaitan dengan aktiviti manusia dan kesan daripada rebakan bandar di sekitar Kuala Lumpur dan Negeri Selangor. Perbandaran di Selangor mula menghampiri kawasan tadahan air empangan dan sekitarnya. Kawasan tadahan air empangan juga terdedah kepada konflik guna tanah, dan lain-lain ancaman seperti pembuangan sampah secara haram, masalah persekitaran yang dibawa oleh pemancing seperti sampah dan penggunaan motor bot, pembersihan tanah, dan yang lain-lain. Cabaran dalam sistem pengurusan empangan sedia ada di Selangor adalah seperti kelemahan dalam penguatkuasaan, konflik guna tanah dan pertindihan pelaksanaan undang-undang berkaitan dengan tanah, tiada integrasi antara agensi-agensi yang berkaitan, isu peruntukan penyelenggaraan dan pengurusan, kekurangan kepakaran dalam sistem pengurusan empangan, kurangnya undang-undang, peraturan, garis panduan, manual, pelan strategik dan kekurangan kesedaran awam. Bagi mewujudkan sistem pengurusan empangan mapan, Selangor perlu mengambil tindakan dengan mewujudkan akta khas keselamatan empangan, menambahbaik garis panduan dan penguatkuasaan, menyediakan pelan strategik, melaksanakan kawalan guna tanah, menggalakkan kolaborasi antara agensi terlibat dalam pengurusan empangan dan akhir sekali adalah dengan meningkatkan kesedaran orang ramai mengenai kepentingan empangan sebagai sumber bekalan air utama di Selangor.

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LIST OF SYMBOLS AND ABBREVIATIONS

ANCOLD	:	Australian National Committee on Large Dams Incorporated
ASDSO	:	Association of State Dam Safety Officials
DSC	:	Dam Safety Committee
FEMA	:	Federal Agency Management Agency
HEC	:	Hydrologic Engineering Centre
ICODS	:	Interagency Committee on Dam Safety
ICOLD	:	The International Commission on Large Dams
IUCN	:	World Conservation Union
METT	:	Management Effectiveness Tracking Tool
MIDC	:	Malaysia Inter-Department Committee
NDSP	:	National Dam Safety Programe
NID	:	National Inventory of Dam
NSW	:	New South Wales
SDM	:	Sustainable Dam Management
SDMETT	:	Selangor Dam Management Effectiveness Tracking Tool
SWMA	:	Selangor Water Management Authority
SYABAS	:	Syarikat Bekalan Air Selangor
WTP	:	Water Treatment Plan
WCPA	:	World Conservation Of Protected Area
GIS	:	Geographical Information Systems
DID	:	Department of Irrigation And Drainage, Malaysia
DOLA	:	Depaertment of Land Administration (Australia)
CALM	:	Department of Conservation and Land Management (Australia)
CDM	:	Canada Dam Management

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CHAPTER 1: INTRODUCTION

1.1 Introduction

The biggest challenge in dam management in Malaysia is maintaining the water supply to meet the development needs. Every year, during the dry season, dam water level are always become a main issues related to the water shortage problems especially in Kelang Valley. Malaysia has also experienced with the disaster related to the dam overflow at The Sultan Abu Bakar Dam in Cameron Highland. The floods in Kelantan in December 2014 were also linked to the dam ability to accommodate the increasing quantities of the water. There are some issues related to the invasions of the dam basin area by illegal angler. Dams in Malaysia are also vulnerable to the environmental threats, such as climate change, earthquakes, and landslides. Old dam structure will also become as an issues. It is clearly shows that Malaysia is confronted with a major challenge in the management of dams.

Until now, there is no act or law officially related to the dam safety in Malaysia, to manage and coordinate all dam owner, operator and related agencies. Dam management in Malaysia needs more improvement in term of laws and regulation, strategic plan, coordination, land use control and etc. all.

The Sustainable Dam Management Systems are involves the whole aspect of management in order to overcome the management issues and problems in the dam development. Dam management systems are used to reduce the reverse impact between dams, humans and the environment. Reverse impact means, when dam development, affect humans and the environment with changes in ecological, and socio-economic. Instead of humans and the environment also having an influence on to the dam with the development pressures, land use conflicts, climate change, earthquakes, landslides and the old dam structure.

Towards a sustainable dam management system, in Malaysia, Sustainable Dam Management Policies by World Commission On Dam should be implemented as appropriate with issues and challenges in the management of dams in Malaysia. This research will assess issues and challenges in dam management system in Selangor and evaluate the existing dam management system in Selangor by applying the Dam Management Effectiveness Tracking Tool and SWOC analysis as a decision making tool, to propose the strategic plan and framework for dam management system in Selangor.

1.2 Problem Statement

Population increase not only describes the increase in demand for drinking water but there is an added challenge for water resources to meet the demands of agriculture, industries and energy use. River is in many instances dammed to provide for this increase in societal needs for water resources. However, river basin is also been exploited for many another uses and in many cases the exploitation of its slope and channels for resources like land, minerals, vegetation, had gravely altered the process. As a response regime of the basin system and affect the quality, quantity and sustainability of water resources associated with the river dams.

Development versus water resource is a big issue in Selangor. Every year during the dry season water shortage and dam water level always becomes a hot topic. Rapid development in Selangor exploited the natural water resources, but in the same time this rapid development increases the demand for drinking water and industries. Since the three main rivers in Selangor already polluted, it's making dams an important water resources for Selangor. But resentment, almost all dam water levels in Malaysia are in the critical level. This situation happened because of the current factor from high demand of water resources from industries, population, and the limited or exploited natural water resources area.

Dam management is an important aspect in ensuring the safety and sustainability of water supply sources in Malaysia. But the current dam management system, focusing only on the management of the dam structure and technical aspects.

In fact, dam management needs to have a more holistic focus. Not only focusing on the management of the dam structure and technical aspects, but also focusing on the environment surrounding the dam, both environmentally and human.

Human activity in fact, indirectly influences the overall safety level of the dam including the structure and the catchment area. Whatever activity occurs within the dam basin, will affect the quality of the reservoir and the dam structure.

For example, lands clearing activity will cause land erosion, water pollution and sedimentations in the dam reservoir. All of these processes not only affect the quality of the water, but also threaten the structure of the dam to accommodate the increasing of water mixed with sediment.

Challenges in Malaysia Dams Management System is, the problems of development and agricultural approaching the dam area, old dam structures, landslides, climate change and earthquake issues. All issues and problems that are a barrier to the achievement of the implementation of a sustainable dam management system in Malaysia.

Development areas are approaching with the interference issues such as illegal garbage dump, fishing, and illegal stalls. All interference activities lead to the negative impact on the dam water quality and dam structure.

Agricultural activities also lead to the negative impact on the dam structure and function. Agricultural land clearing within the dam water catchment area will load high sedimentation and make a dam reservoir become shallow. The sediments filed with the base of the dam also put pressure on the dam structure. During the rainy season, the dam is exposed to the failure. It's happened twice to the Sultan Abu Bakar Dam at Cameron Highland, Pahang. On 23 October 2013, four people are confirmed dead due to flash floods when Bertam River overflowed due to release of water from dams Sultan Abu Bakar, Ringlet. The incident was further destroyed about 80 homes and several cars in Bertam Valley settlements. Heavy rains on 22 and 23 October causing large amounts of water flowing into Lake Ringlet together solid waste, sewage and siltation resulting from land clearing and agricultural activities in the upstream areas. The victim can be prevented in the second instance on November 8, 2014 as the population on the banks of Sungai Bertam ordered to evacuate before the Sultan Abu Bakar Dam water release in stages (Berhad, 2013). Agriculture activity also gives an influence to the dam water level. Gemencheh Dam in Negeri Sembilan had a lower water level. This situation happened because of the palm oil plantation in the dam water catchment area.

Weather is a global issue that also affects the function and safety of the dams in Malaysia. Extreme weather conditions such as heavy rainfall will influence the ability of the dams to accommodate the increase in water level. Often flash floods are due to the release of water from dams in Malaysia. Klang Valley is experiencing frequent problems of flash floods caused by the overflow of the dam. According to the Malaysian Meteorological Department, La Nina is responsible for three of the wettest years on record (1984, 1988 and 1999) for East Malaysia. A La Nina event led rainfall levels to increase and flooding happened in Taman Sri Muda Shah Alam in December 1995, Kuching in 2003, Kuala Lumpur in 2005, Petra Jaya in 2000 and Sibu Sarawak in February 2009. Heavy rains led to the overflow of the dam. At the same time, urban development is causing significant disruption in the flow of rivers and urban drainage systems. Finally, climate change brings the floods.

The influence of weather on the dam also happened in dry weather. According to the Department of Irrigation and Drainage (DID), hot and dry weather causes water retention; as a result almost all major dams across the country are shrinking. Langat Dam went from the normal level of 220.96 meters to 217.10 meters. Klang Gate Dam from 94 meters to 90.26 meters, and Sungai Selangor Dam water levels went from 220 meters to 199.65 meters. According to the Executive Director of Puncak Niaga, operation and maintenance, Abdul Rashid Abdul Satar, raw water levels in three major dams in Selangor only lasted for 70 to 172 days following the hot and dry weather that hit the country since the beginning of February 2014. Klang Gates Dam only survived for 70 days, Langat Dam, 84 days and Tasik Subang Dam for 172 days. The reservoir area was hit by climate change. Extremely hot and dry weather has hit the decline in the dam water level. Every year during the dry season dam water level always linked with the water shortage problem issues. The dam is facing the low water level during the dry season is the Dam in Selangor. Meanwhile, the others state dam is Mengkuang Dam in Penang, again Gemencheh Dam in Negeri Sembilan Durian Tunggal Dam in Melaka and Timah Tasoh Dam in Perlis.

Most dams in Malaysia are the old dam structure. There are 72 dams in Malaysia, 15 of which are more than 50 years old; 29 dams are between 25 and 50 years old and 28 dams are under 25 years of age. About 60 percent of the dams are of earth fill type. 20% of dams in Malaysia began to show recurring maintenance problems. It is also to be noted the safety review of the Bukit Merah Dam (1906) conducted in 1998. The Dam Safety Review of the Sungai Perak Hydroelectric scheme comprising the Temengor (1978) and Chenderoh (1930) dams carried out in May 2003. There are not any public records to discover conducted maintenance on the rest of the older dams in the country. It is worth mentioning that collection is constrained due to a shortage of funds and personnel (Zainal Abidin, 2006).

Currently earthquakes have been the main threat to dam management in Malaysia. This issue needs urgent preventive action from the country. Earthquakes are common in the southeast Asian region. Indirectly, earthquakes affect dam, especially old dams. An earthquake may lead to a dam's failure. Cracks have occurred because of earthquakes at the Timah Tasoh Dam in Perlis, Malaysia (Sekitar, 2011). According to a report from the Malaysia Meteorology Department, from 7 to 17 April 2012 earthquakes frequency in this region, such as north and south Sumatera, Sulawesi Indonesia, range from 5.0 to 6.1 on Richter scale; the vibration can be felt in West and East Malaysia.

Bakun dam has caused much controversy when its construction affects the environment and social issues. Bakun Dam has resulted in the displacement of 10000 people, from 1,640 families and some fifteen indigenous communities mostly in Kayan and Kenyah ethnic group. Resettlement are often cause hardship. Those are displaced, many of them unable to find a permanent job or unable to continue their agriculture or hunting activities (World Commission on Dams, 1999).

Selangor State is the most develop state in Malaysia make a land use in Selangor is rapid changes. The urban area is started sprawl to the dam basin area. This situation makes a conflict of interest between development and water resources reservation. It lead to conflict in hydrology cycle in Selangor State in water resource management generally and dam basin specifically.

All dam in Selangor is functioned as a water supply and river flow regulator and some as flood mitigation. Highly rapid development makes water supply demand for domestic uses, industrial, business and etc., al are increase. Meanwhile, at the same time the development started to approach the natural area, include the location of the water resource. This resulted in leakage in hydrology cycle in Selangor, where water demand increases without the water reservation. This makes Selangor State always facing the water shortage crisis whenever the dry season and dam water level in Selangor always become hot news in media.

In terms of legislation, the act related to the dam safety still do not exist in Malaysia. This situation complicates the work of enforcement, administration, and management in holistic manner.

It is time, Malaysia and Selangor, in particular, to strengthen the existing dam management system by taking into account the environmental, human and economic elements as well as empowering the dam management system through technical and structural engineering aspects.

This is because dams are a combination of reactions between the three elements namely human, dam structure and the environment. Humans create a dam structure to meet their needs. The structure of the dam acts to block and water the river. The river then as the environment reacts with the formation of reservoir ponds. This clearly demonstrates the three elements which humans, dams and the environment are affect each other. Hence, in the pursuit of sustainable dam management systems, these three elements need to be taken into account in the overall dam management system.

For Overcome all of the issues about the dams, control and monitoring measures should be taken immediately, but unfortunately, there have been no special act for dam safety in Malaysia. There only has an Inter-Departmental Committee on Dam Safety, was established in May 1986, under stewardship of Public Works Department Malaysia.

Apart from that committee, has successfully published the guidelines for operation, maintenance and surveillance of dams. Unfortunately is merely a guideline that is not enforceable by law.

1.3 The Theoretical Framework and Model

The relationship between dams, humans and the environment is a reverse interaction. They are influences each other. Usually developing dams affect humans and the environment in the form of changes in ecological, and socio- economic. The preliminary study on dams concentrates more on the impact of dam development on humans and the environment. “Resettlement, or the involuntary and forced transfer of people, has already come to as among the most significant negative impacts of large water development projects such as dams” (Bartolome *et al*., 2000). In addition to human resettlement, dams have a significant impact on the environment. For instance, “dams change flow regimes, sediment supply, and seed transport, one might expect downstream reaches to have lower diversity” (Clausen, 2000). Dams have a major affect on rivers mainly through the changes in the timing, size, and low and high flows, finally producing a hydrology regime significantly differing with the pure impoundment natural flow regime (Magilligan & Nislow, 2005). “builds a dam on a river can block or delay moves upstream fish and will contribute decline and extinction species event. Especially the species which depend on longitudinal movement along the stream” (Larinier, 2000). Power dams release significant amounts of carbon dioxide and methane, and occasionally produce more of these greenhouse gases than power plants running on fossil fuels (Graham, 2005). Occasionally dams are used to the diseases vector breeding. According to Goldsmith, dam reservoirs become a breeding medium for some disease vectors, such as mosquitoes for malaria and freshwater snails for schistosomiasis diseases (Goldsmith & Hildyard, 1984). Rivers deposit considerable debris in dams, resulting in the disruption of the natural spread pathways and resulting changes in river communities (Jansson *et al.*, 2000). Sometimes, “dams debris the river of the continental United States and that their impact on river relief is several times greater than influences considered likely because of global climate change” (Graf, 1999). Dams change rivers to reservoirs, with accompanying changes in erosion and sedimentation, chemistry and temperature, fauna and flora (Carson & Beavers, 2002). This occurs with a disastrous dam failure or a dam burst. After such events, researchers began focussing on the reasons for the dam’s failure. The biggest reason assisting in the failure of the dam is the environmental cause. The main impact of the environment on dams is events such as an earthquake. Earthquake analyses reveals that cracking of concrete limited to areas near the upstream and downstream faces of dams, especially in the upper parts and occasionally also near the heel, contribute significantly to dam breaks. Estimated cracking takes into consideration the assumed tensile strength (Pal, 1974), earthquake impelled sliding for different types of construction materials and earthquake shaking intensities (Seed, 1979). The influence and impact of earthquakes on dams motivates researchers to study the dam design considered to be earthquake resistant where “the earthquake load relies on time variant ground acceleration applied in the upstream–downstream direction of the arch dam” (Seyedpoor *et al.*, 2009). In addition to earthquakes, landslide factors should also be included in the dam design and planning. It is important to have an understanding of geomorphic forms and the involvement of landslide-dam formation, stability and failure, part of which is inherent in the often passing nature of stream blockages in a coupled hill slope-valley (Kurop, 2002). Additional impact of the environment to the dam’s role is the climate change and extreme weather. The impact of climate change on stream temperatures below dams is more when the water released is from the reservoir surface rather than the deep water (Sinokrot *et al.*, 2002). Weather also makes an impact on the dams. Flooding has caused several recent failures and the resultant damage to dams (Gruner, 1963). Wind also causes dam damage as noted in a study conducted by two authors that note, "multiple dam breaches resulting from waves is resulting from wind. Waive overtopping studied for a theoretical long not strong earthly dam with an uneven crest" (Wang & Bowles, 2006). Third, the impact of the environment to dams is seen in impact on plants and animals. According to the Federal Emergency Management Agency (FEMA), embankment dams are vulnerable to damage from wildlife intrusions. Twenty-five states in U.S. stress that animals have caused or contributed to unsafe or outright failure of an embankment dam. Numerous animal species excavate burrows, tunnels, and den entrances for shelter, while other predatory animals will enlarge these by digging in search of prey (FEMA, 2005). Plant damage caused to dams occurs in the form of uprooted trees that caused large voids and lessened the side, decaying roots that create leach ate paths, problems of internal erosion, falling trees causing possible damage to spillways and outlet, and clogging the embankment under the drain (FEMA, 2005). Based on previous studies on dams, dams have a greater influence on the environment and humans. Continued studies also show the environmental and human causes to dams. Humans build dams to meet their needs. Dam development, has an impact on humans and the environment in the form of resettlement and river and ecology changes. Afterwards, the impacted environment will have an impact to the dam in the form of disaster (dam failure) and that impact will eventually return to humans. Human impact is defined in the form of land use conflict. Conflicts of land use lead to a variety of interferences and pollution problems at the dam water catchment area. Numerous dam watersheds in Australia have experienced problems of land use conflicts. For instance, Mungalup, Quinninup and Serpentine Dam Catchment Area, indicate that there are other land uses besides forest in the water catchment boundaries. There are tracks around the reservoir allowing full access to the water body. Recreational use will lead to potential risks on water quality includes breeding of pathogens, wildfire, the turbidity, nutrients and landfills. Mungalup dam water catchment area has a native title in the form of a land title that recognises the unique ties to some Aboriginals (Water and Rivers Commission, 2007). Based on the above discussion it is shown that between humans, dams and the environment, there is a reverse interaction where they are influencing each other.

In Malaysia, the dam is a catalyst for national development from the physical and economic social aspects. There are 74 dam in Malaysia, which consists of various types and functions, (Azizi, 2011). All dams in Malaysia are owned and operated by different agencies such as the Department of Irrigation and Drainage, Water Supply Department, Energy Supply Company (TNB), State Government and other agencies according to their respective needs and responsibilities. The Administration, Management, Maintenance and Security of the Dam Structure are under the responsibility of each agency involved. This means that the management of dams is implemented separately according to their respective agencies. To date there is still no agency or supreme body having authority or carrying out the task of monitoring all owners and management of dams in Malaysia in compliance with the security aspects of dam management. Even though there is an Inter-Departmental Committee on Dam Safety was establish in May 1986, and this committee has successfully published the guidelines for operation, maintenance, and surveillance of dams, but this guidelines and this committee are not enforceable by any law.

The dam management system in Malaysia is now more focused on security management or more accurately in relation to the maintenance of the dam structure alone. Management documents relate more to technical and engineering aspects only such as technical problems in the Northern Flood Flow at Bukit Merah Dam, where there are some small cracks in the 'spillway crest', (Azizi, 2011). Small cracks also occur in Chenderoh Dam, Perak. The dam type is concrete dam, where The first cracks were seen in 1953 and a format report on cracking and corrosion damage to the gate valves sector made in 1954. Although the structure of the dam does not face the risk of failure and is still safe to operate, however, the impact of cracking needs to be improved as soon as possible. It is noticed that there is no corrosion effect on the base or the occurrence of sedimentation, (Azizi, 2011).

In Malaysia there is less research that continues to align with the dam management system in a sustainable manner. The previous study focused on the impact of the dam development on humans and the environment and the impact of human activities and environmental events on water quality as well as the structure of the dam. The dam impact to the human is done by the study about the Population perception of relocation of Bengoh Dam Settlement Area, Kuching Sarawak, where this study found that the majority of the population supported the relocation proposals, (Angin, 2009).

The dam impact to the human is done by the study about the Population perception of relocation of Bengoh Dam Settlement Area, Kuching Sarawak, where this study found that the majority of the population supported the relocation proposals due to key factors such as the provision of basic facilities, according to family needs, according to others, the government's demand and had to move because of the absence of land for planting in the old areas, (Angin, 2009). The assessment of the value of compensation for relocation was also reviewed. There have a lack of freedom and rights of settlers to participate in resettlement processes bring about dissatisfaction towards compensation, for the resettlement of the indigenous communities in Bakun Hydroelectric Dam, Sarawak (Lee, 2014).

Furthermore, research on the impact of dam on the environment in Malaysia is more focused on the impact on the river, especially in relation to water quality and sedimentation. There have a study on Selangor River Water Quality Index (WQI) after the construction of Selangor River Dam has been conducted in 2008. The results show that the overall WQI of Selangor River may be categorized as Class III, (Jaafar *et al*., 2009). Study relate to the water quality impact also done with an Assessment of Water Quality of Batang Rajang at Pelagus Area, Sarawak. The results showed that most stations at main river were categorized as slightly polluted while most tributaries were clean according to the Water Quality Index. The river is suffering from organic pollution where almost all stations along the river contained high chemical oxygen demand (≈ 43.1 mg/L) and total ammonia nitrogen (≈ 0.520 mg/L) and were classi ed as Class III and IV at most of the stations. High suspended solids (218.3 mg/L) and low dissolved oxygen (4.6 mg/L) were observed at the main river. The low dissolved oxygen content from the Bakun dam upstream of the study area has an impact on the river particularly during dry season where DO dropped below the minimum required for sensitive aquatic organisms, (Ling *et al*., 2017).

Further research on the impacts of environmental phenomena on dams is on sedimentation, risk of earth quakes and slides movements. A study on the sediment size distribution and determination of sediment density profile in the selected area of Muda dam catchment area, Kedah. Results showed that the grain size distribution of sediment ranges from gravel to clay sizes. In the reservoir and downstream of the river, most of the samples studied consisting of fine sediment, silt and clay sizes (<63fim), (Kamarudin Samuding *et al*., 1999). Next study about the sedimentation is the study of Sediment balance of the lowland tropical reservoir of Timah Tasoh, Perlis. A study was carried of out to assess the sediment balance of a shallow Timah Tasoh Reservoir (Area: 191 km2). Streamflow gauging and water sampling was carried out at three river inputs to the reservoir, and at the reservoir outlets. River water samplings were carried out every two weeks but frequent and intensive sampling during storm events. The land use in the catchment area ranging from urban area to agriculture, sugar cane, rubber, paddy, rural villages, small towns, quarrying and mining activities. Suspended sediment load data was used to derive the sediment balance. Jarum River (S1), Upper Pelarit River (S2) and Chuchuh River (S3) produced 10,032.3 t; 6,439.2 t; 1,061.4 t of sediment respectively while suspended sediment yield in S1, S2 and S3 were 155.8 tkm-2yr-1, 150.7 tkm-2yr-1, and 71.7 tkm-2yr-1 respectively. Storms play a major role in transporting sediment from the catchment areas. Almost 88.7% of the total suspended sediment yield is transported from S1, 56.7% from S2 and 80.1% from S3. The annual sediment output load at the reservoir outlet was 1 653.0 t. From the total of 17 532.9 t of suspended sediment input to the reservoir, 15 879.9 t was stored in the reservoir. The estimated trapping efficiency of the reservoir is 90.6%, (Rahaman & Ismail, 2013). Beside the sedimentation earthquake risk to the dam structure also has been highlighted in the study of the recent Bukit Tinggi earthquakes and its relationship to major structures. This study present the cause of the recent, small and shallow intraplate earthquakes in the Bukit Tinggi area. The results of the study show that the earthquakes are located at or near to the intersection of three sets of major lineaments trending N-S, NW-SE and NE-SW. This corresponds to the N-S faults, the NW-SE Bukit Tinggi and Kuala Lumpur fault zones and the NE-SW faults, respectively. this study are highlight Peninsular Malaysia must take into consideration the possible seismicity due to the reactivation of ancient major faults zones, the seismicity due to tremors from seismic waves generated with epicentres located in Sumatra and rarely, major dam-induced seismicity, (Shuib, 2008).

The ancient slide study in dam area are done by the research about Reactivated ancient slides at the Sungai Kelalong Dam site, Bintulu Sarawak, East Malaysia. This study are highligt the occurrence of massive landslide on the spillway slope and part of the neighbouring core trench wall was largely attributed to the intersection of low angle, listric normal fault and the subvertical, E-W striking fault zone. Reactivation of the ancient slide is caused by the extensive earthworks activities for the dam construction which resulted in massive landslide to the spillway slope. This case study gives clear examples of the importance of geological inspection during the construction stage to check and to detect any structural defects that were not identified in the previous site investigation works. (Jamaluddin, 2004).

In Malaysia the dam is also used as a source of freshwater fisheries. There have a study about the function of the dam as a source of Malaysia freshwater fisheries. The study is about the Status of Reservoir Fisheries in Batang Ai Hydroelectric Dam, Sri Aman, Sarawak. Results shows that the average fisheries production in the reservoir range from 17.12 to 20.55 kg ha-1 yr-l. Therefore, proper management of the reservoir should be done to sustain the fisheries production in Batang Ai Hydroelectric Dam, Sarawak, (Nazereen & Rosli, 2014).

The impact of human activity on the dam is also explained by the study of The impact of land use in the catchment of Batang Ai and reservoir fisheries on Batang Ai hydro-electric power (HEP) lake. This study explained The lack of farm land at Batang Ai Resettlement Scheme had lead to an increased in the number of resettled communities to come back to utilize their former NCR lands which were not submerged by the construction of the hydro-electric power dam. Increased in population of the area resulted in the increased for land use and water resources utilization. The result shows that the water of Batang Ai HEP Lake, Batang Engkari and Batang Ai is still viable to support economic activities at that area. The lake has been utilized to cater for the large scale cage culture activities managed by the some community groups, individuals, and government agencies. This study also found that there were changes in the population of fish species of Batang Ai before and after the construction of the dam. A number of fish species of the former river had disappeared and were being replaced by the introduced species in the lake,(Bagat, 2005).

Based on previous studies, many dam development effects have been studied in detail, but all of these studies have not been used or used in improving the existing dam management system of the country. On the other hand, previous studies only become useful scientific studies but are not fully applied in the management of the dam. The information and findings from previous studies if collected it will help strengthen the quality of the existing dam management system framework. Yet until now there has been no study that specializes in the overall and comprehensive dam management system. It is time that Malaysia has taken steps to restructure the existing dam management system toward a sustainable dam management system. The main step is to taking into account the previous scientific study of the dam, whether studies relate to the impact of the dam on the environment and humans, or the impact of the environment and human activities on the dam to strengthen the existing dam management systems. Other than that, existing management systems should also emphasize technical and engineering aspects, particularly those relating to dam structure. To ensure technical issues, engineering, sedimentation, water quality, pollution and other issues with the dam can be addressed. Malaysia needs to strengthen the system of administration, management and enforcement by establishing and enforcing dam security laws. Information, research, findings and all information and issues related to dams in Malaysia have been discussed. It is only a matter of time to apply all of the previous findings to strengthening existing deployment systems to be sustainable and efficient. Therefore, this study will lead to the creation of a sustainable model of sustainable dam management system in Malaysia and Selangor in particular.

1.4 Aim

Water is a crucial environmental component. Water will affect the continuing existence of human life and its associated livelihood activities. Human civilizations are known to involve and perish because of water. This study aims is to understand the role of dams in water resources development planning in Malaysia and what would constitute a Sustainable Dam Management System For Selangor and Malaysia. In order to realize these aims the study examines the issues and challenges affecting dam management in State of Selangor as it is the most rapidly developing state in Malaysia where the demand of water resources is at a very critical cross road.

1.5 Research Objectives and Questions

1.5.1 To examine the main characteristics of dams in Selangor

i What are the type, function, size category and disaster class of the existing dams in selangor

1.5.2 To assess the issues in the Selangor dam basins

ii What are the type of activities in Selangor dam basins ?

iii What are the type of development within 3 kilometers radius from Selangor dam basins border ?

iv What arectype of land use in Selangor dam basins ?

v What arecthe type of land ownership in Selangor dam basins ?

1.5.3 To evaluate the effectiveness of the existing dam management systems in Selangor

vi What are the generic and spesific components of the Selangor dam management systems ?

vii What are generic and spesific issues and challenges in Selangor dam management systems ?

viii Is the dam management system in Selangor effective?

1.5.4 To develop a sustainable dam management system model for Selangor

ix What is the appropriate sustainable dam management systems for Selangor?

1.6 Data Acquisition and Research Model

Primary data was collected from an interview session on the administration and enforcement of the dam catchment area with related and involved agencies. The Data were also used, collected via a personal interview with the Deputy Director of Selangor Water Management Authority (SWMA). The interview related to the interference occurring in the dam water catchment area and was carried out in a site visit. Results of the site visit helped digitize the interference location in the form of maps. Processed maps are overlaid with secondary data involving dam water catchment area border (GIS Data, from Selangor Water Management Authority) to analyse. Meanwhile, secondary data were gathered from a literature review of official document reports from agencies involved, such as SWMA, of the interference issues happening in the dam water catchment area. This included the newspaper reports related to the arrest of an intruder in the catchment area of the dam, Water catchment border (GIS data from SWMA), built up area maps (GIS Data from Peninsular Malaysia, Town and Country Planning Department), information from the Malaysia Meteorology Department regarding climate change and earthquakes, and the Department of Irrigation and Drainage (DID) and the dam operator regarding the level of water in the dam. Detail of data acquisition and analysis will be elaborate in chapter 3.

1.7 Research Scope

This study is limits to the five, research objective and limits to the seven main dam in Selangor state. The dam engaged is a Klang Gate dam and Batu Dam In Gombak District, Semenyih Dam and Langat Dam in Hulu Langat District, Sungai Tinggi Dam and Sungai Selangor Dam in Hulu Selangor district and last, the Tasek Subang Dam in Petaling District. And this study also is limits to the dam management challenges in Selangor during 2011 to 2014.

1.8 The Study Region

Seven main dams in Selangor are selected as a study area for this research. Because all dams in Selangor are located surrounding the development area in Selangor State and Klang Valley. Seventh dam in Selangor is located facing towards the built-up area and the major growth centers. See (Figure 1.1). Sungai Tinggi Dam and Sungai Selangor dam are located in Hulu Selangor District, which located in the northern part of Selangor State. Tasek Subang Dams is the only dam in the Petaling district at the center part of Selangor. In the east part of Selangor there is a Hulu Langat District was the location of Langat and Semenyih Dams. Batu Dam and Klang Gate Dam are the nearest dam in the urban area with located in the Gombak District.

All Dams are located in four main river basins. There have eight river basins in Selangor, but the three main river basins in Selangor are Klang River Basin, Langat River Basin and Selangor River Basin. All dams located upstream the river, and are located on a different river. There have no dams in the state built-in terraces level. Sungai Tinggi Dam and Sungai Selangor Dam are located in the Selangor River Basin. Batu Dam and Kelang Gate Dam are located in the Kelang River Basin. Langat Dam and Semenyih Dam are located in the Langat River Basin. Only one Dam is located in Buloh River Basin is Tasek Subang Dam. Generically all dams in Selangor are located upstream in deference river. On average, every two dams in the state are located in the same river basin, except Subang Lake Dam is a dam only found in the river basin buloh. Selangor dams character is different from other places because of the suitability and the presence of suitable sites to build dams is limited. It is also dependent on the height factor. See (Figure 1.1)

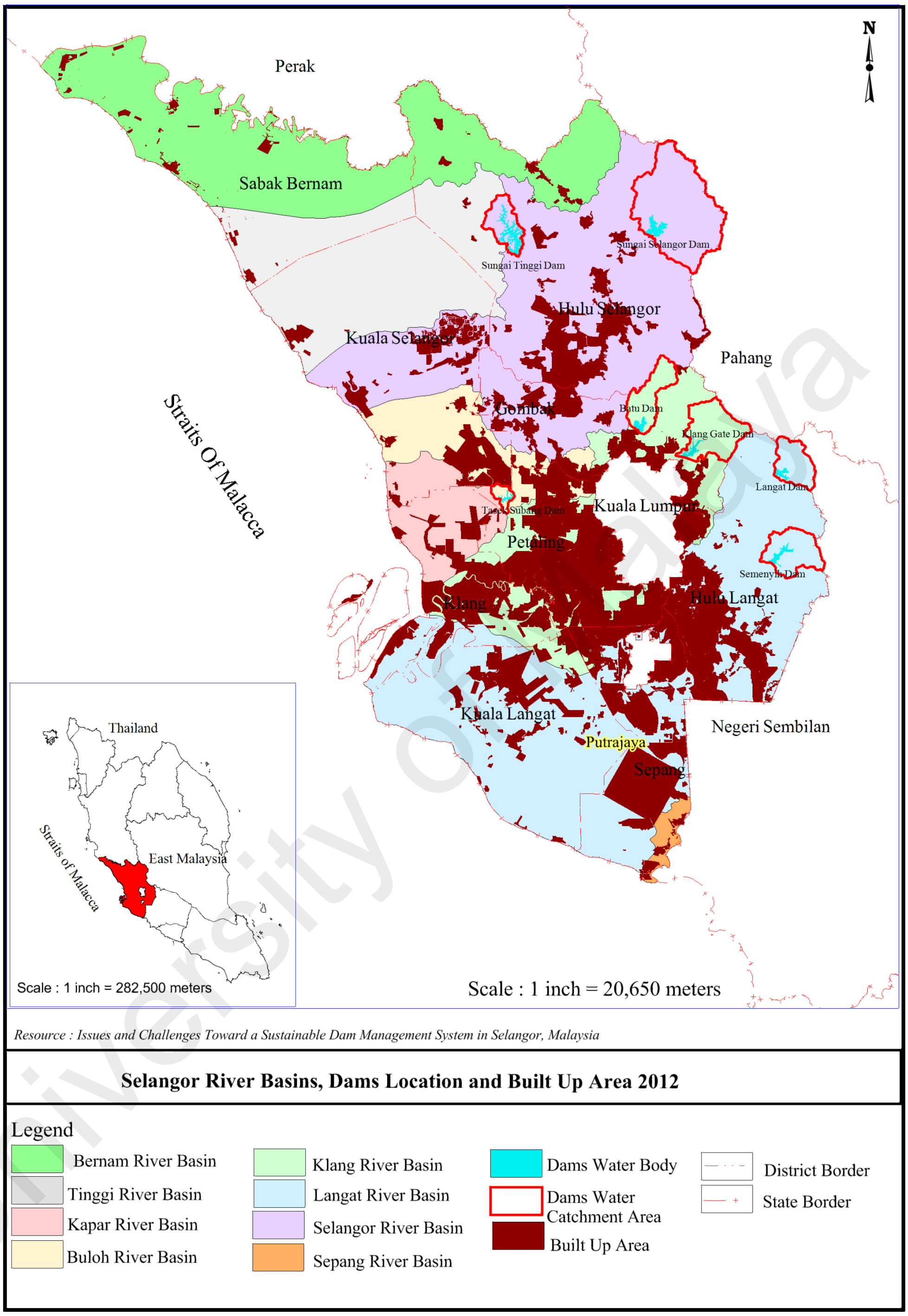


Figure 1.1: Selangor River Basins, Dams Location and Built Up Area 2012

1.9 Organization of The Thesis

This study will discuss, criticize and highlight new issues on Dam management system in Selangor. Where included the issues, challenges, factors, strength and weaknesses of the existing management system.

The discussions will be divided to seven chapters. First chapter is Introduction (Chapter One) that will be discussed about the main structure of this study. That included the problem's statement, research aims, research objective research question, the study region, data acquisition, analysis model and scope of research.

Chapter Two will look into the review of literature, which included theoretical model and a theoretical framework. This chapter will guide this study to contribute with others previous study or some critical point of current knowledge to give an added value and quality for this study. This chapter will be divided in to five working model (Dam, Issues, Challenges, Evaluation and Sustainable Dam management). The information and conclusion of this for a working model will be discussed with the Final model at the end of this research in chapter Discussions (Chapter six).

Research Methodology will be discussed in Chapter Three – Data Acquisition and analysis. This chapter will explain the techniques and methods of analysis to be used in this study, starts from research objective, research question, research techniques, research hypotheses, sampling, data collection, data collection methods, data sources, data analysis techniques and interpretation of data.

Next chapter is The Study Region – River Basin and Dams in Selangor (Chapter four). This chapter will explain about the study region are involved in this study. Where the area is dealt with in this study is the dam and dam water catchment area in Selangor.

There have been seven main dam in Selangor means this study will cover seven location of dam in Selangor State. The detail discussion will relate with the river basin system.

Result and Interpretation will be discussed in Chapter Five. This chapter will discuss detail result for each research question. At the end of this chapter the SWOC analysis will be conduct to develop a sustainable dam management systems for Selangor. As a final result, the final model finding of this study will discus in this chapter to compare with the working model in the next chapter in (Discussion).

Discussion on chapter Six will be discussing and comparing the working model with the final model explaining to look a similar or gaps in knowledge about the dam management.

All result, discussion and conclusion will conclude in last Chapter (Chapter Seven) it is Chapter Conclusion and suggestion. This chapter will highlight a new knowledge are develop from this research.

The overall research will track the issues and challenges in dam management systems that are happened in Selangor by identify the found in dam basin, study the existing administration and management system, identify strength and weaknesses and lastly find the improvement action and suggestion in existing dam management system in Selangor towards sustainable dam management system and also sustainable water resources management and sustainable development in Selangor.

1.10 Conclusion

This chapter is discussion about research structure of this study. That leads by the research title " Issues and Challenges Towards Sustainable Dam Management In Selangor Malaysia". Base on Figure 1.2 Research Keyword and Thesis Organization The Issues statement in the title is linked with dam issues in problems statement. With challenges keyword link with the problem statement for implementation of laws and regulation and compliance issues is linked with the Sustainable Dam Management System Keyword. Meanwhile, Selangor and Malaysia, keyword are representing the study region dam and river basin system. All the problem statement is linked with one aim for this research, to understand the role of the dam in water resources development planning in Malaysia and what would constitute a sustainable dam management system in Selangor.

From the reach the research aim this study must examine the main characteristic of the dam in Selangor, to assess the issues, to examine the existing dam management system, to evaluate and to propose the sustainable dam management systems for Selangor as an objective of this research.

As a guide, each objective has own review of literature. To examine the main characteristic of the dam in Selangor, this research need to review the main type, function, size and disaster class of dam in the world. This Review will represent as "Dam" keyword in a working model.

To Asses the issues in the dam basin in Selangor, review will be included about the previous study on dam issues such as dam development impact, environmental impact and land use issues in the dam basin. All discussion about dam issues will represent the "Issues" keyword in research working model.

To Evaluate the effectiveness of existing Dam Management System this study will review the Dam Management include issues and challenges in others country. This review will represent the “Challenges” keyword in research working model. This study also will review the management effectiveness evaluation tool and frameworks are suitable to evaluate the dam management system. Since they have no existing dam management system. This review will represent the “Evaluation” keyword in working model.

To develop a sustainable dam management systems model for Selangor this study will review the Sustainable Dam Management System by World Commission on Dam. This review will represent by a “Sustainable Dam Management” keyword.

All review of literature will come out with a Thesis Working Model that leads by four keyword, Dam, Issues, Challenges, Evaluation and Sustainable Dam Management. From thesis working model, this research will guide with nine (9), research question as listed in Figure 1.2. This research question will involve the data acquisition process and analysis included the SWOC analysis of all information and result. From the result and interpretation, will formed in one final model with four (5) keyword such as Dam characteristic in Selangor, Dam issues in Selangor, Dam Management issues and challenges in Selangor and Selangor Dam Management effectiveness evaluation score and Sustainable Dam Management Systems.

From all keyword from the final model will be discussed and compare with working model in chapter 6 (Discussion).

The final of this thesis will develop the sustainable dam management system for Selangor. The end of this thesis, all issues and challenges toward sustainable dam management system in Selangor, Malaysia and knew knowledge will be conclude.

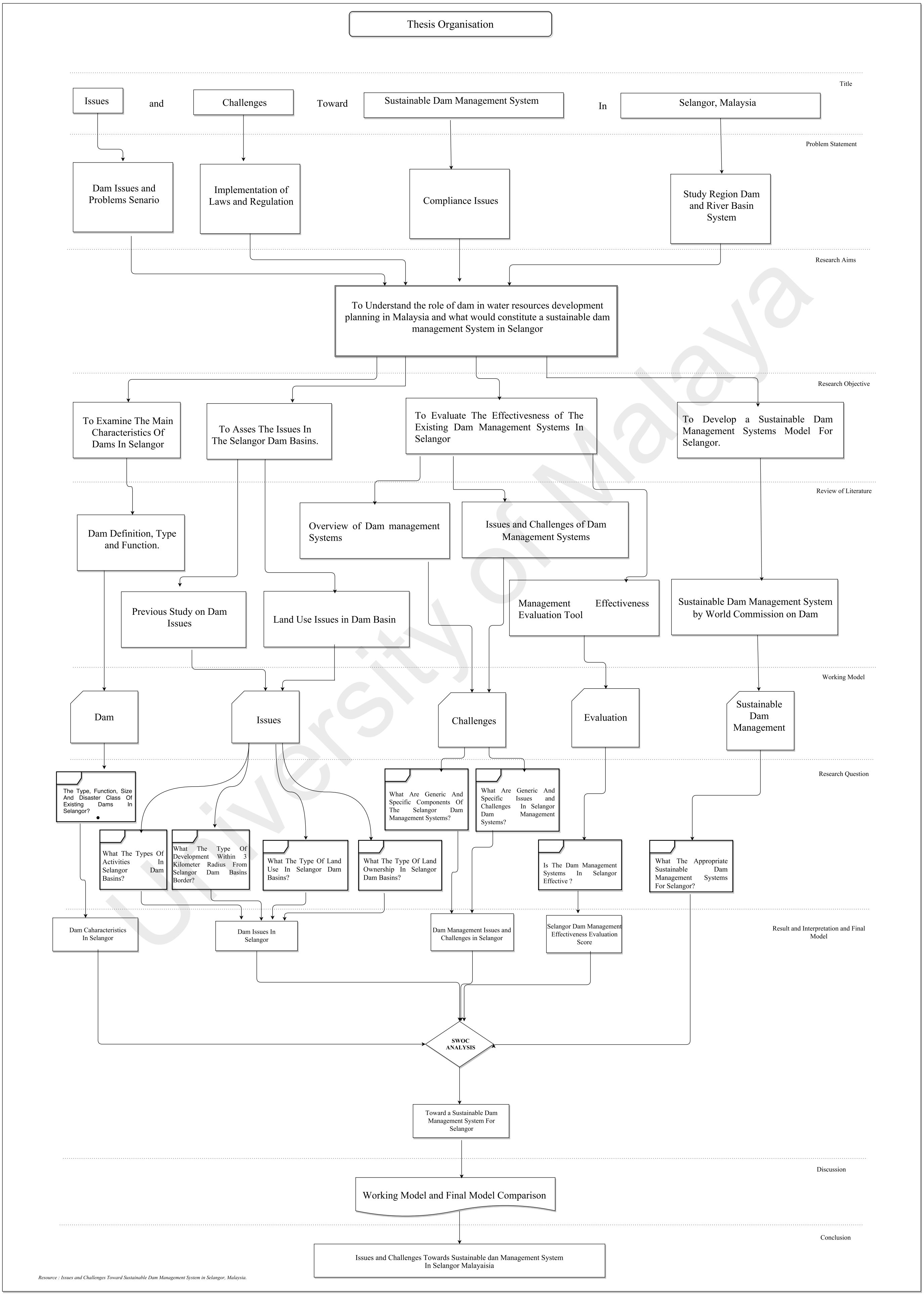


Figure 1.2 : Research Keyword and Thesis Organization

CHAPTER 2: THEORETICAL FRAMEWORK AND THE RESEARCH MODEL

2.1 Introduction.

Dams are engineering structures that are built to impede river flow and the resultant reservoir formed are used as potential water resources for diverse human activities that include agriculture, industries, settlements, hydro-electric power and many other human needs. This multi-dimensional function of dams described their continued importance in sustaining growth and development the evolution of various ancient and human civilizations and their demise too. Malaysia as in any other rapidly developing country, is very much dependent on its water resources. The development of dams and reservoirs provides a regular source supply for this very important resource. However, a dam is a structure built across a river channel that drains a larger system of the river basin. The river basin is exposed to other forms of human activities especially those that don't abide to land use development planning in the upper basin regions. This activity is occur on the valley slopes and within channel slopes. There are much exposed to the effects of the water cycle processes.

The water cycle processes created movements of sediments and solutes, which would meet the river channel on which the dam is placed. These inputs of sediments and solutes would eventually influence the quantity, quality and sustainability of the reservoir water. In the long term, the functions of the dam would be compromised. There are numerous attempts to address the problems associated with quantity, quality and sustainability of the reservoir water retention capacity. However, the rapid exploitation of upper basin systems creates a tremendous challenge in managing the threat and in many cases leads to the recurrence of the threat. Sustainable dam management system must be incorporated within a bigger framework of an integrated river basin management system especially in upstream catchment. This is not an easy task, as the term "sustainable" is a very elusive term to achieve but it does the way for minimal environmental degradation that could affect the quantity, quality and availability of the reservoir water. The main focus of an integrated river management system is to determine the relationships between issues, its causal factor, and the effects also impacts on the water flow processes in the river basin. This knowledge is essential as it provides the needs to set up and implement the integrated river basin management system. SWOC, analysis could be utilized to understand existing strengths, weaknesses, opportunities and constraints prior to its implementation. In summary, these theoretical discussions describing dams and water resources development in the context of river basin development can simplify in a theoretical model as showed in Figure 2.1. This theoretical model will constitutes the Research Working Model and describe the aim, objectives and questions about the research. The working model would be enhanced based on the results and interpretations accrued from the present study to develop a final model that describes the present research.

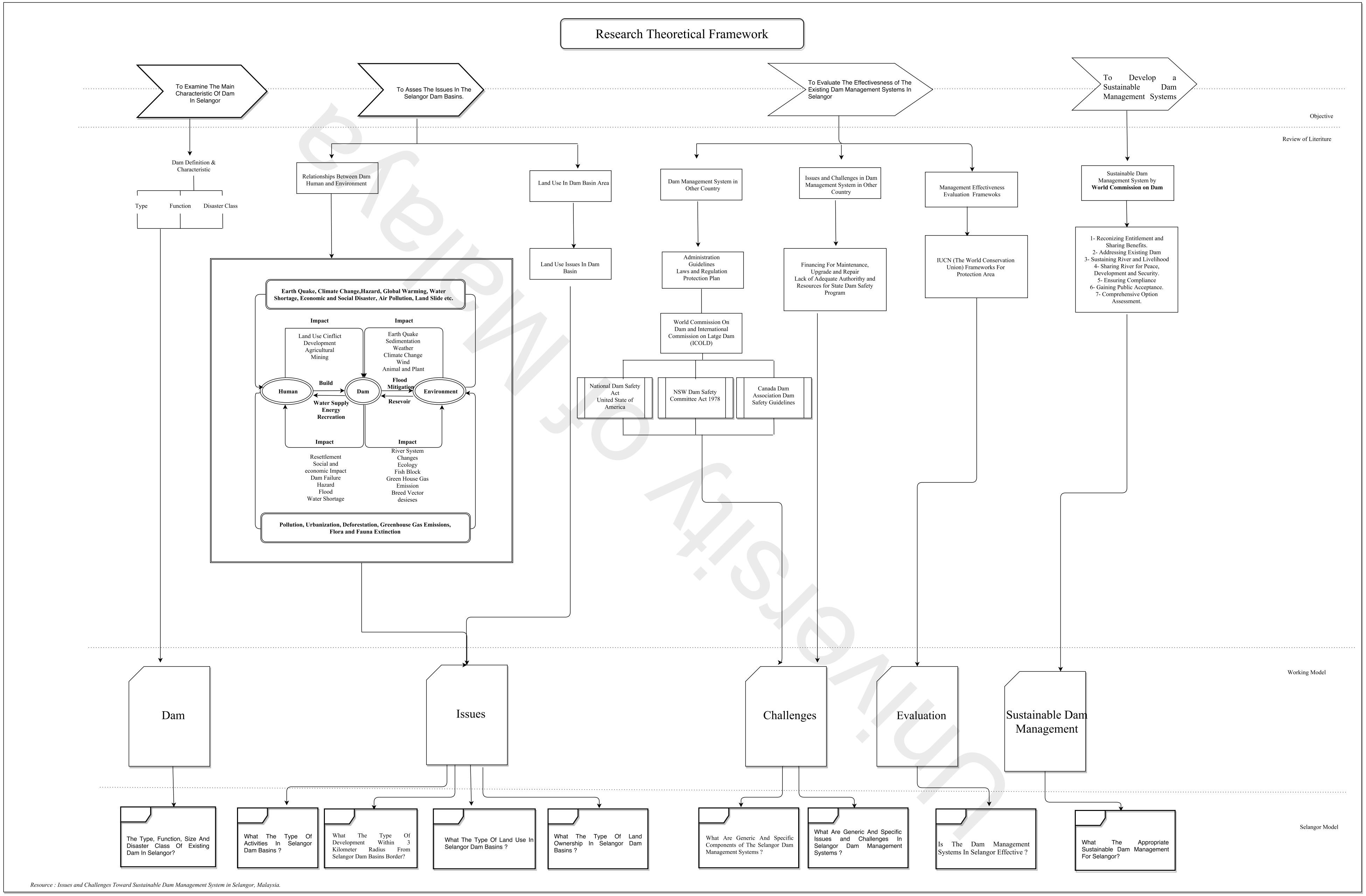


Figure 2.1 : Research Theoretical Model

2.2 Dams Definitions, and Characteristics.

2.2.1 Dam Definitions

Dam is a barrier or structure across a stream, river or waterway to confine and then control the flow of water. Dams come in variety size from small earth embankments often for farm use of high massive concrete structures generally used for water supply, hydropower and irrigation (International Commission on Large Dams, 2009). Dams have provided mankind with such essential benefits as water supply, flood control, recreation, hydropower, and irrigation. They are an integral part of society's infrastructure, especially as tool to manage and maintain the water resources for human life (Hill, 1996). Dam is the structure that established by human to meet their need. A dam is identified as a barrier or structure across a stream, river or waterway to confine and then control the flow of water. Definition of a Dam Revised 09/11/2009 - A Dam is any artificial barrier which impounds or diverts water which: has a height of 6 feet or more, is located at the outlet of a great pond, regardless of height or storage, or is an artificial barrier which impounds liquid Industrial or liquid commercial wastes, or septic or sewage, regardless of height or storage. Some Roadway Culverts are considered dams New Hampshire's (2009).

The above definition can be concluded that whatever of type function or size, Dam is a structure who was built by human to meet their own need especially water resources. And at the same time, the development of the dam has changed the environment especially the river system. In other ways, human also gives an impact to the dam structure and dam area as will be dealt with in this study. Marib dam in Yemen began around 750 BC is a first dam in the world and took 100 years to complete (Cohen, 2008). This dam history is showing that human built the dam for their needs without control and the natural man was savagely disregard the safety aspects of the dam; finally it will give an impact back to the human life. The destruction of the dam is noted in the Qur'an Chapter 34 (Saba). Verses 15-16, and the consequent failure of the irrigation system provoked the migration of up to 50,000 people. It also happened to the next generation dam. Almost of dam failure are happened because of the negligence human behavior in developing and managing the dam, environment and their water resources. It shows in the interaction between humanity and the dam is reversible interaction.

In noun Dams is a barrier constructed to hold back water and raise its level, forming a reservoir used to generate electricity or as a water supply and in verb, dams means build a dam across a river or lake where the river was dammed to form Lake Powell, dams also is a hold back or obstruct something where the closed lock gates dammed up the canal (dictionaries). Dams are one symbol of development and societal progress, and dams are now concurrently seen as structure impairs natural river functioning (Dams, 2012).

Dam is man-made, but some animal such as a beaver, also builds dams. All dams have a wall, foundation, pipes, and spillways. Without these important part of the dam cannot do the job for which it has been designed (Leliavsky, 1981). Others view, dams are an inextricable element of human society, human built dams for a multitude reason and at increasingly great cost (Collier *et al.*, 2000). Dams, means any artificial barrier that has the ability to impound water, wastewater, or any liquid borne material, for the purpose of storage or control of water, that is 25 feet or more in height from the natural bed of the stream channel or watercourse measured at the downstream toe of the barrier, or if the barrier is not across a stream channel or watercourse, from the lowest elevation of the outside limit of the barrier to the maximum water storage elevation (U.S National Dam Safety Program Act, 2000).

Dam is also has an impounding capacity for maximum storage elevation of 50 acre-feet or more. Dams also have a storage capacity at maximum water storage elevation that is 15 acre-feet or less regardless of height. Some barrier, depending on the location of the barrier or another physical characteristic of the barrier, is such as to pose a significant threat to human life or property if the barrier fails.

Definition of New Hampshire's Departmental of Environmental service, Dam" means any artificial barrier, including appurtenant works, which impounds or diverts water and which has a height of 6 feet or more, or is located at the outlet of a great pond. A roadway culvert shall not be considered a dam if it's invert is at the natural bed of the watercourse. It is sufficient discharge capacity, and it does not impound water under normal circumstances. Artificial barriers which create surface impoundments for liquid industrial or liquid commercial wastes, septic, or sewage, regardless of height or storage capacity, shall be thought dams (Water Management and Protection).

According to Dams, dams are an obstruction, built on a stream or a river to collect water behind it. And reservoir means, is an artificial, seasonal or permanent lake, that is created at from the dam structure and used for the purpose of Irrigation, Drinking, Land reclamation, Electricity generation, Fishing, Recreation and (or) Protection of towns from flood danger.

As a conclusion dam is a man-made structure. It is constructed to meet the needs of human life, especially as a source of water supply. Through time, human activities are still moving forward into the complex activities of the so-called development. And this progress requires the more complex of reservoirs function and role. Where, in the past is used as water resources. But now its role expanded to flood control, power generation, recreation and so on. Dams also said as generator development of city, state, country and also nationally. This shows the dam is an important part of human life and development. Hence the existing dam should be alert and well managed and organised to avoid disaster and adverse effects on human civilization.

2.2.2 Dam Functions

Generally dams are initiated to solve a human problems and need, first dam were built for irrigation. One of the earliest dams built for the navigation (Turpin, 2008). Dams have a several main function for human life and the environment. Dams serve as structure to accommodate the variations in the hydrologic cycle. Dams and reservoirs are needed to store water and then provide consistent yearly supply for human needed. Water stored in reservoirs is also used for industrial needs such as from the direct use in chemical and refining processes to cooling for conventional and nuclear power production. Managed flows from reservoirs can be used to dilute discharged substances by augmenting low river flow to maintain water quality at safe limits, (International Commission On Large Dams (International Commissions On Large Dam, 1997).

Dams also help meeting the agricultural demand for food supply where one of the biggest uses of water on a worldwide scale is agricultural irrigation. This will account for about 1147 liters per day per capita by the year 2000. Since the early 1990s, less than 1/5 of the land suitable for agriculture in the world has been irrigated, and it has contributed about 1/3 of world food production. It is estimated that 80% of additional food production by the year 2025 will come from irrigated land. Most of the areas in need of irrigation are in arid zones, which represent a major portion of the developing countries. Even with the widespread measures to conserve water by improvements in irrigation technology, construction of more reservoir projects will be required (International Commissions On Large Dam, 1997). Dams form an essential part of the infrastructure of many countries. Control of water, whether for agriculture, public or industrial supply, or flood alleviation is a prerequisite for social and economic development (Midttomme, 2001).

Above, mains function of the dam shows that dams is very important in human life needed. Where not only serve as a Water supply dams also plays a role as a flood control, hydropower, land navigation, support the needed in agricultural and industrial towards a continued socio-economic development.

2.2.3 Dam Types

Dams come in deference shape and sizes. There are four type of dams made by human, arch dams, gravity dams, embankment dams and buttress dams, the type of dams that is built depend on why is it needed and place where it is to built (Leliavsky, 1981).

Embankment dams are a ridge of earth or rocks made by humanity to stop water from overflowing. (Leliavsky, 1981). According to British Dam Society, embankment dams are mainly made from natural materials. The two main types are earth fill dams and rock fills dams. Earth fill dams are composed mostly from compacted earth, while rock fill dams are made up mainly from dumped and compacted rock fill. The materials are usually excavated or quarried from nearby sites, preferably within the reservoir basin. A cross-section of Figure 2.2: Embankment Dams cross-section, through an embankment dam shows that it is determined like a bank, or hill. Most embankment dams have a central section, called the core, made from impermeable material to stop to water going through the dam. Clayey soils, concrete or asphaltic concrete can be used for the core (Society, 2012). Embankment dam is only type of dam not made of concrete today. They are made of rock fill or earth fill. They have two advantages over the other dams type, fist, the construction material is obtained locally and is straight forward to set up which keeps down the cost of construction. Second, the large base area of the dam means, that is relatively little pressure upon the foundation (compared to the additional dam type of dam) and embankment can be built where the other type cannot. They are a fine for wide valley, or open jointed (loose-porous) rock, because they are relatively low weight per unit area and are not particularly susceptible to earthquake damages. And the core issues of the embankment are it because of their construction material, they are water permeable. This, problems can cause erosion and eventual destruction of the dam unless addressed (Denny, 2010).

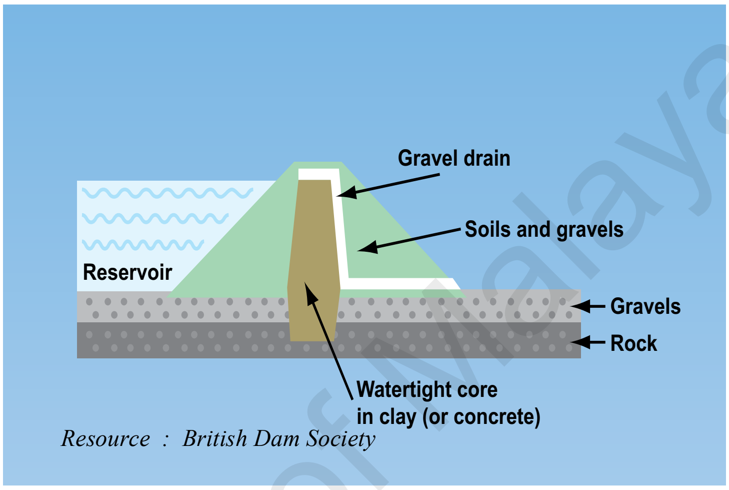


Figure 2.2: Embankment Dams Cross-section

Arch dams are composed of concrete. They are curved in the shape of an arch, with the top of the arch pointing back into the water. An arch is a strong shape for resisting the pushing force of the water behind the dam. Arch dams are generally constructed in narrow, steep sided valleys. They need good rock for their foundations, and on the sides of the valleys, to resist the forces on the dam (Society, 2012). Refer Figure 2.3: Arch Dam Cross-section. Most dam wall is built-in the shape of an arch because it is a very strong shape, (Leliavsky, 1981).

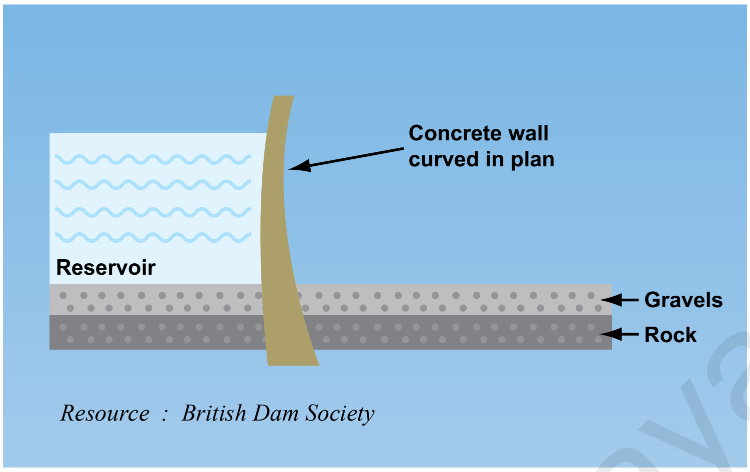


Figure 2.3: Arch Dams Cross-section

A gravity dam is composed of concrete or masonry, or sometimes both. It is known as a gravity dam because gravity holds it down to the ground stopping the water reservoir pushing it over. A cross-section of Figure 2.4: Gravity Dams cross-section, through a gravity dam will usually look roughly triangular. Gravity dams are suited to sites with either wide or narrow valleys, but they need to be built on sound rock (Society, 2012). Gravity dam theory is. “gravity is a force that makes the thing fall where you drop them” (Leliavsky, 1981).

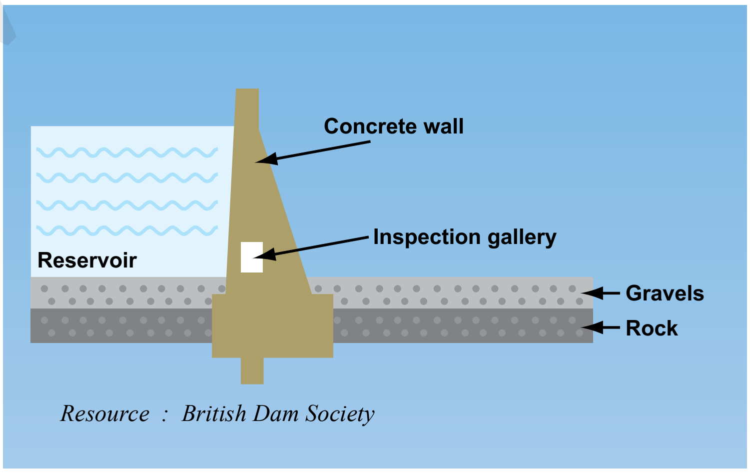


Figure 2.4: Gravity Cross-section

Buttress Dams are composed of concrete or masonry. They have a watertight upstream side supported by triangular shaped walls, called buttresses. The buttresses are spaced at intervals on the downstream side. They resist the force of the reservoir water trying to push the dam over, refer Figure 2.5: Buttress Dams cross-section. The buttress dam was developed from the idea of the gravity dam, except that it uses a lot less material due to empty spaces between the buttresses. Like gravity dams, they are suited to both narrow and wide valleys, and they must be built on sound rock (Society, 2012). Buttress dams are a support for a wall (Leliavsky, 1981).

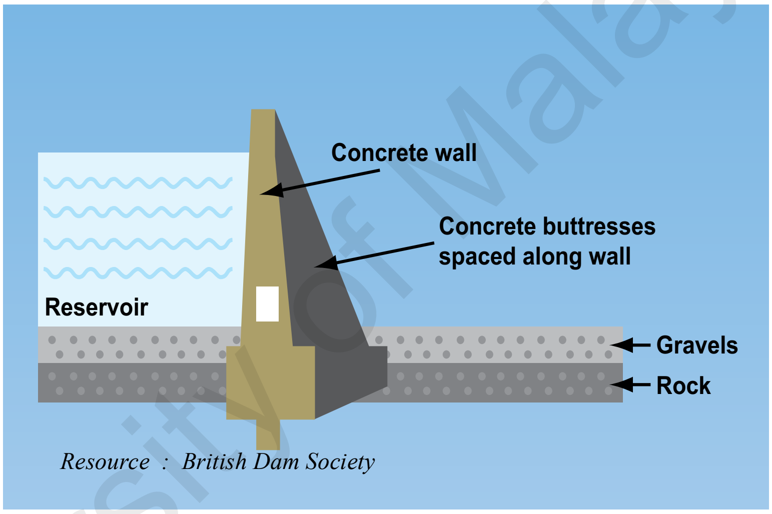


Figure 2.5: Buttress Dam Cross-section

2.2.4 Dam and Disaster Class Hazard Potential

Regarding to the Federal Guidelines For Dam Safety: Hazard Potential Classification System For Dams Report, hazard potential as the possible adverse incremental consequences that result from the release of water or stored contents due to failure of the dam or mis-operation of the dam or appurtenances. Where there has been classification in term of hazard and disaster class. It is low, significant and high. Low hazard potential, dams assigned the low hazard potential classification as those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are mainly limited to the owner's property. Significant hazard potential, dams assigned the significant hazard potential classification as those dams where failure or mis-operation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be positioned in areas with population and significant infrastructure. High hazard potential, dams assigned the high hazard potential classification as those where failure or mis-operation will probably cause loss of human life (Federal Emegency Management Agency, 2004) see Table 2.1: Dam Hazard Classification.

Table 2.1: Dam Hazard Classification

Hazard Potential Classification	Loss of Human Life	Economic, Environmental, Lifeline Losses
Low	None expected	Low and generally limited to owner
Significant	None expected	Yes
High	Probable. One or more expected	Yes (but not necessary for this classification)

Resources : Federal Emergency Management Agency (FEMA). (2004). Federal Guidelines for Dam Safety: Hazard Potential Classification System for Dams, April 2004, U. S. Department Of Homeland Security Federal Emergency Management Agency October 1998

2.3 Previous Study Interactions Dam, Human Being And The Environment - International

Interaction between dam, human and environment will be discussed about these previous study of the dam. From all the literature review about the previous study on dam issues, can be concluded that all the study can be divided to three type, categories or ways of study. Fist impact of dam development on the environment and human, second impact of the environment of the dams and third impact of the human activities at the dam. The three categories shown that they have an interaction among human, dam and environment. The interaction is involved is a reversed interaction, where the dams, environment and human are influenced and give an impact to each other. This reversed interaction will be considered on a theoretical framework on dam, environment and human interaction. Previously there have been a lot of study on the impact of the dam development to the environment an impact of the environment or natural disaster in the dam and human. This research will cover the third categories of the study of dams, where this study will identify the impact of human activities to the dam's area in Selangor state. And to highlight a new issue on dam study especially impact of the human activities in the dams studies.

2.3.1 Dam Development Impact

Dams affect many ecological aspects of a river especially for the fish. A large dam can cause the loss of entire ecospheres, including endangered and undiscovered species in the area, and the replacement of the original environment by a new inland lake. Large dams have been criticized because of their negative environmental and social impacts (Lerer & Scudder, 1999).

2.3.1.1 Resettlement

In the initial stages of dam's development, Dams will involve the relocation of potentially large human populations. Displacement or the involuntary and forced relocation of people has come to be acknowledged as among the most significant negative impacts of large water resources development projects such as dams (Bartolome *et al*., 2000). The record for the largest population relocated belongs to a Three Gorges Dam was built-in China. The World Commission on Dams had estimated global total of 40 to 80 million dams resettles "have rarely had their livelihoods restored". China has some of the most ambitious dam proposals and the Three Gorges

Dam on the Yangtze River will be the largest in the world operating in 2009 (WCD 2000: 129). Others study about the Three Gorges Dam in China shows that TGD is China's largest engineering and infrastructure project since liberation. It will affect the lives, habitat or economy of at least 20 million people above the dam and another 300 million downstream. The human impact of relocating at least 1.3 million Three Gorges people at a time of rising national unemployment and major economic reforms.. (Jackson & Sleigh, 2000). This statement is contradicting with others reseach, where they said. Dams also act as a powerful vehicle for poverty alleviation (Tortajada *et al*., 2012).

Over 400,000 people have been resettled as a direct result of dam construction in Africa. The issues of resettlement in Africa are different where, settlers on African schemes have for the most part been initially happy with better access to water, transport, schools, medical care and social services, and marketing links (De Wet, 2000). Others cases of resettlement are in Indonesia, from 1985 to 1988, the Saguling and Cirata hydropower reservoirs in the highlands of West Java, Indonesia, displaced more than 40,000 families. As part of a comprehensive resettlement plan, an attempt to resettle 3,000 families in water-based floating fish cage aquaculture and land-based aquaculture support was initiated (Costa-Pierce, 1998). In India, people displaced by the Nagarjunasagar Dam Project are selling their babies to foreign adoption agencies. The government intervened and put the babies in two public hospitals where six babies died of neglect. According to a detailed study of 54 Large Dams done by the Indian Institute of Public Administration, the average number of people displaced by a large Dam is 44,182 (Roy, 1999). In Guatemala, More than 400 people have been victims of the violence related to the filling of the Chixoy dam, Some of them still remain unknown, National Institute of Electrification in 1976, 150 were from Rio Negro, until 1981 the strongest group in terms of culture and with an entirely indigenous population

(Colajacomo & Chen, 1999). Adverse social impact of dams construction, whether short-term or cumulative, has been seriously under estimated. Large-scale water resources development unnecessarily lowered the living standard the million of local people, (Dorcey *et al*., 1997).

2.3.1.2 Changes On River And Ecology

After the social impact of resettlement, Dam is negatively impact the environmental conditions in the river. The sedimentation and sediment retention in the valleys is more intensive, when the dams are not high ($H \leq 4$ m) and their ponds do not overflow into floodplains. Grass in the flooded meadows entrap the sediments and decrease the water contamination below dam (Vaikasas & Rimkus, 2011). In early stages of dam's development, dam will bring the influence to the surround, (McCully, 2001). The reservoirs have flooded vast areas at least 400,000 square kilometers have been lost. Design and operating pattern of every dam is unique because every river is unique in terms of its flow patterns, the landscapes it passes through and the species it supports. Some of the environmental effects of a dam only can be found in the long period of time. The most significant impact of the dam to the environment is tended to fragment the riverine ecosystem, isolating populations of species living up and downstream of the dam and cutting off migrations and other species movements (McCully, 2001). Others study said, Dams impose changes of flow and sediment transfer that drive changes in channel form along the downstream regulated river (Sedell *et al*., 1990). In United State, dams fragment the fluvial system of the continental United States and that their impact on river discharge is several times greater than impacts deemed liable as a result of global climate change (Graf, 1999). A large-scale hydro-project is defined as one or a chain of engineering structures, whose operation may obviously change the hydrological or hydraulic conditions of the river on which it is constructed and Water diversion has becomes an important stress causing changes in fluvial processes (Wang

& Hu, 2004). In term of ecology impact, riparian areas are heavily impacted by dams and, despite their high biodiversity and ecological importance, continue to be threatened (Clausen, 2012). Dams change rivers to reservoirs, with accompanying changes in erosion and sedimentation, chemistry and temperature, fauna and flora (Carson, 2002). The study of the ecological impact of the dam done by others researcher, shows, the changes in the number and diversity of macroinvertebrate communities were observed showed their flexi-bility and resistance to habitat transformations. The ecological structure of benthos communities changed from the dominance of reophil species which inhabited shallow water with strong currents to the dominance of stagnophil species preferring stagnant, slow moving water (Rybak & Sadlek, 2010).

2.3.1.3 Breeding Ground For Disease Vectors

Dams also can become breeding grounds for disease vectors. Hydrographic modifications also have the potential for adverse impact on the health of local populations. The extension of water sources and their all year round supply of water mean that people are attracted towards them, and to the same places where conditions favour the spread of intermediate hosts and vectors of parasitic diseases such as schistosomiasis, onchocerciasis, dracunculiasis and malaria (Ripert & Raccurt, 1987). Tigris region in northern Ethiopia, overall incidence of malaria in the villages close to dams was 14.0 episodes/1000 child months at risk compared with 1.9 in the control villages—a sevenfold ratio. Incidence was significantly higher in both communities at altitudes below 1900 m (Ghebreyesus *et al.*, 1999). The use of dams, both large and small, and the culture of rice in paddy-fields produces enormous expanses of water which are suitable breeding grounds for mosquitoes and snails, the vectors of human diseases such as malaria and schistosomiasis in sub-Saharan Africa. They are, however, of lesser importance in Asia and the Americas (Mouchet & Carnevale, 1997). The development of water resources, particularly in Africa, has switched the face of the continent, opening up land for agriculture, providing electric power, encouraging settlements adjacent to water bodies, and bringing prosperity to poor people. Unfortunately, the created or altered water bodies provide ideal conditions for the transmission of waterborne diseases and a favorable habitat for intermediate hosts of tropical parasitic infections that cause disease and suffering. The recent progress in control of these waterborne and vector-borne diseases, such as guinea worm, schistosomiasis, lymphatic filariasis, and onchocerciasis (Fenwick, 2006).

2.3.1.4 Green House Gas Emission

New investigations emphasise that shallow and tropical reservoirs have high emission rates of the greenhouse gases CO_2 and CH_4. Methane emissions contribute strongly to climate change because CH_4 has a 25 times higher global warming potentials than CO_2. The pathways for its production include ebullition, diffuse emission via the water-air interface, and degassing in turbines and downstream of the reservoir in the spillway and the initial river stretch. Greenhouse gas emissions are reinforced by a eutrophic state of the reservoir, and, with higher trophic levels, anaerobic conditions occur with the emission of CH_4. This does mean that a qualitative and quantitative jump in greenhouse gas emissions takes place (Gunkel, 2009). Existing hydroelectric dams in Brazilian Amazonia emitted about 0.26 million tons of methane and 38 million tons of carbon dioxide in 1990 (Fearnside, 1995). Global large dams might annually release about 104 ± 7.2 Tg CH_4 to the atmosphere through reservoir surfaces, turbines and spillways (Lima et al, 2008). The different categories of hydropower plants in view of the two main sources of GHG emissions: first, direct and indirect emissions associated with the construction of the plants; second, emissions from decaying biomass from land flooded by hydro reservoirs (Gagnon & Van De Vate, 1997).

2.3.1.5 Fish Block

The building of a dam generally has a major impact on fish populations, migrations and other fish movements can be stopped or delayed, the quality, quantity and accessibility of their habitat, which plays an important part in population sustainability, can be affected. Fish can suffer major damage during their transit through hydraulic turbines or over spillways. Changes in discharge regime or water quality can also have indirect effects upon fish species. Increased upstream and downstream predation on migratory fish is also linked to dams. Fish being delayed and concentrated due to the presence of the dam and the habitat becoming more favourable to certain predatory species (Larinier, 2000). In Australia, dams have generally resulted in adverse impacts to native riverine fishes while encouraging exotic species. This has been assigned, in part, to disruption of seasonal flood cycles, and to dams acting as barriers to fish movements. The Murray River now has the lowest commercial fish yield per km2 (Jackson & Marmulla, 2001).

2.3.1.6 Dams Failure / Burst

The last and the worse impact the dam development of the human and environment is a Dam Failure disaster. Relating to the Emergency Management Division, Washington Military Department, Dam failure is the uncontrolled release of impounded water resulting in downstream flooding, which can affect life and property. Flooding, earthquakes, blockages, landslides, lack of maintenance, improper operation, poor construction, vandalism, or terrorism cause dam failures (Washington Military Department, 2013).

Dam and levee failure involves the overtopping, breach, or collapse of the dam or levee. Dam and levee failure is especially destructive to neighboring development during flood and hurricane events (Alamo Area Council Of Governments, 2012).

Based on the above discussion on the impact of dam development on the environment and human, it can be concluded that the dam will bring both good and bad effects on the environment and human beings. Good co-building effects of the dam are to fulfill the basic requirements of the human and socio-economic development in terms of agriculture, development, industry and municipalities. Effects of dam development are structured in several stages. The first stage dam construction will involve the resettlement and the relocation of people and the habitats in the surrounding area, deforestation also occur in a larger context. The second stage of the development impact of the dam is the effects are come from the effects of the dam on the first level where the drowned timber, will contribute to greenhouse gas emissions. Dams also disturb the natural ecological cycle in particular fish and wildlife habitat in the river. Third stages are related to the environment resulting from the dam's reservoir characteristic, where some of the dam's catchment area become a vector breeding places which dangerous and spread of diseases. Adverse effects of dam development are sequential. Where it will eventually have an adverse effect on humans. Then its will become a complete cycle where humans build dams for their own and effects of the dam development were back to the human in the form of good and bad.

2.3.2 Environmental Impact To Dam

2.3.2.1 Land Slide

There is still a considerable lack of understanding of geographic forms and processes involved with landslide-dam formation, stability and failure, part of which is inherent in the often ephemeral nature of stream blockages in coupled hill slope-valley systems (Korup, 2002). In other studies about the landslide and dam, the resulting geomorphological-typical rock-avalanche dam deposit created a dam that impounded water volume of 4–7×106 m3 at lake full level. This lake was released by the catastrophic collapse of the landslide, which occurred at 16:20 (local time) on 10th July 2004, after reported smaller failures of the saturated downstream face. The dam failure released a flood wave that had a peak discharge of 5900 m^3 s−1 at the Kurichhu Hydropower Plant 35km downstream (Dunning *et al.,* 2006).

2.3.2.2 Earth Quake

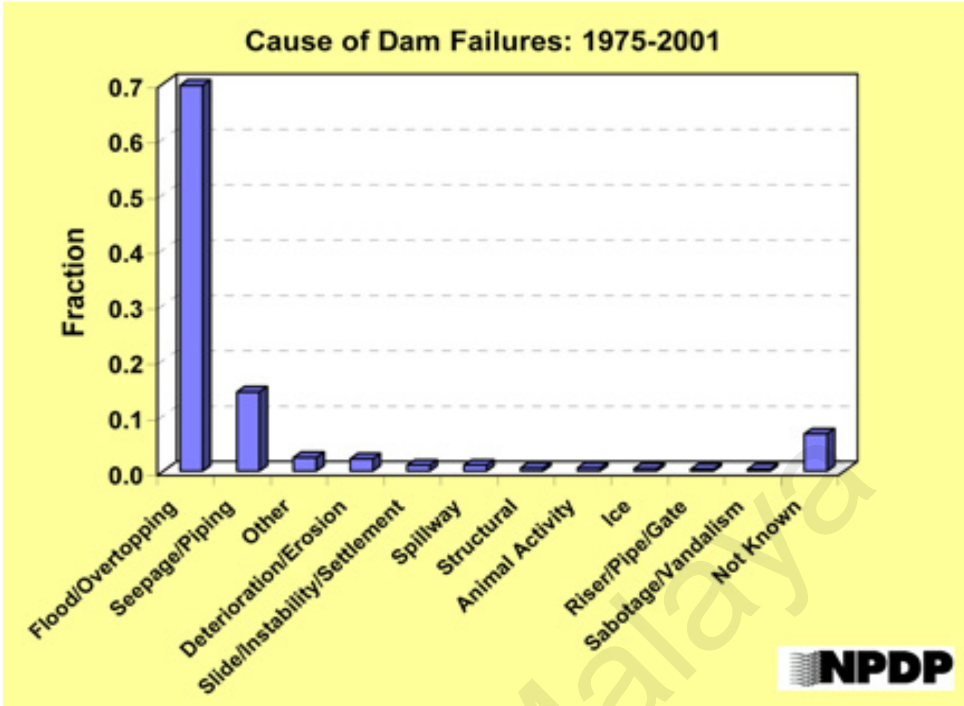
Earthquake can cause a dam to break. (Leliavsky, 1981). Chinese historic documents recorded that on June 1, 1786, a strong M=7.75 earthquake occurred in the Kangding-Luding area. Sichuan, southwestern China, resulting in a large landslide that fell into the Dadu River. As a result, a landslide dam blocked the river. Ten days later, the sudden breaching of the dam resulted in catastrophic downstream flooding. Historic records document over 100,000 deaths by the flood. This may be the most disastrous event ever caused by landslide dam failures in the world (Dai *et al.*, 2005). Earthquake analyses reveal that cracking of concrete is confined to areas near the upstream and downstream faces of dams especially in the upper parts and in some cases also near the heel. The estimated cracking is very sensitive to the assumed tensile strength (Pal, 1974). The permanent deformations are estimated for a 135-ft (40-m) high sandy clay embankment that was shaken by a magnitude 8-2 earthquakes and the results are compared with the observed field behavior (Makdisi & Seed, 1977). Performance of dams during earthquakes is reviewed and conclusions are drawn concerning the potential for earthquake-induced sliding for different types of construction materials and earthquake shaking intensities (Seed, 1979). Permanent sliding displacements of dams induced by ground motions with peak acceleration of 0.5g may vary from a few inches to a couple of feet (Chopra & Zhang, 1991). At 14:28 (Beijing time) on 12 May 2008, the catastrophic Ms 8.0 Wenchuan earthquake occurred just west of the Sichuan Basin, China, causing severe damage and numerous casualties. It also triggered a large number of landslides, rock avalanches, debris flows etc (Xu *et al*., 2009). On method analysis of earthquake impact to the dams, has found, A general procedure for analysis of the response of concrete gravity dams to the earthquake, are include the dynamic effects of impounded water and flexible foundation rock, to the transverse (horizontal) and vertical components of earthquake ground motion (Chopra & Chakrabarti, 1981). The available substructure method for the earthquake analysis of concrete gravity dams, including the dynamic effects of the impounded water and the flexible foundation rock, is extended to include the effects of alluvium and sediments invariably present at the bottom of actual reservoirs (Fenves & Chopra, 1984). By the analysis and studies about the impact of the earthquake in dams, earthquake is become a main factor and main influence in dam's structural design. An efficient methodology is therefore proposed finding the optimum shape of arch dams considering fluid-structure interaction subject to earthquake loading. The earthquake load is considered by time variant ground acceleration applied in the upstream–downstream direction of the arch dam (Seyedpoor *et al.,* 2009). Although fill dams have been constructed since olden times, there are only records of recent earthquake damage. Fill dams that are designed and constructed based on the modern design standards have not previously been filed but have been only slightly affected by past earthquakes in Japan and other nations suggests that such large fill dams are highly earthquake resistant. The modern conventional design methods (soil engineering control of the bank soil, method for evaluating slip safety, and evaluation method of the foundation ground) are thus fully adequate for determining earthquake resistance (Tani, 2000). Earthquake also related with the land slide, The serious consequences of failure makes it imperative that dams in seismic regions be designed to resist earthquake shaking safely and economically, the designers of dams must be provided with information about those dams that have been subjected to strong ground shaking, with or without damage (Morriso *et al*., 1977).

2.3.2.3 Climate Change, Flood And Weather Threat

The overall effects of climate change on freshwater systems will likely be increased water temperatures, decreased dissolved oxygen levels, and the increased toxicity of pollutants. In lotic systems, altered hydrology regimes and increased groundwater temperatures could influence the quality of fish habitat (Ficke *et al.,* 2007). Several recent failures and the resultant damage of dams are by flooding (Gruner, 1963).

Linking to Office of Hydrologic Development, National Weather Service, National Oceanic and Atmospheric Administration, USA. Several dam failure happened due to the weather effect from the Hurricane Katrina, (Dam failures and incidents, 2013).

Report on National Performance Of Dam Program, U.S at the figure 2.6: Caused Of Dam Failure 1975-2001 shows that the main factor and caused the dam failure is a flood and overtopping. Where flood and overtopping are a factor who comes from the environmental system. Overtopping of a dam is often a precursor of dam failure. National statistics are demonstrated that overtopping due to inadequate spillway design, debris blockage of spillways, or settlement of the dam crest account for approximately 34% of all U.S. dam failures.



Source: National Performance of Dams Program U.S

Figure 2.6 : Caused Of Dam Failure 1975-2001.

Others study shown, the impact of climate change on stream temperatures below dams is more pronounced when the water release is from the epilimnion (reservoir surface) rather than the hypolimnion (deep water) (Sinokrot *et al.,* 1995). Wind also makes an impact to the dams, higher wind speeds lead to wave overtopping and dam breaches under larger freeboards than lower wind speeds. For a specified inflow hydrograph and spillway configuration, there exists a location at which the smallest estimated peak outflow occurs among all possible breach locations and the pool drops too quickly for additional breaches to develop. Choosing this location for a fuse plug or a pilot channel could minimize downstream influence, perhaps as an interim or emergency measure for a dam with inadequate spillway capacity (Wang & Bowles, 2006).

2.3.2.4 Plant and Animal Impact

The ultimate impact of environment to the dams area is. The impact of the environment of the dams is the plant and the animal impact. Regarding to the Federal Emergency Management Agency (FEMA), embankment dams are susceptible to damage from wildlife intrusions. Twenty-five states in U.S indicate that animal activity has caused or contributed to unsafe operation or outright failure of an embankment dam. Numerous animal species excavate burrows, tunnels, and den entrances for shelter, while other predatory animals will enlarge these structures via digging in search of prey (Federal Emergency Management Agency, 2005). While the impact of the plant on the dam occurs in the form of uprooted trees that produce large voids and reduced freeboard, decaying roots that create seepage paths and internal erosion problems, falling trees causing possible damage to Spillways and outlet facilities and clogging embankment underdrain systems (Federal Emergency Management Agency, 2005).

So that showed that the environment is granted an impact back to the dam. And all this influence is connected to the impact of the human. When the environment is given an impact to the dam and dam failure is happened, it will bring damage to the human. But at the same time, human also gives in impact to the dam area and structure that will cause the disaster back to human himself.

2.3.3 Human Activities Within The Dams Catchment

Human activities impact to the dams are main topic that will be identify and evaluated in this study, where before this, there have many research and study about the impact of the dam to the human and environment, and impact the environment to the dam back. But there are less study highlight of the impact from human activities specially conflict among development and conservation and management of the dam water catchment area. Before this, many studies about the human influence to the dam are more about the technical aspect, maintenances, management, dam structure issues, bad design and careless of human in term of structure and management. Where all human factors to the dam are related with the internal problems from human in dam administration and management.

All of factors are come from the human management weaknesses that are related with people who are involved in the dam industries itself. There have been several dam in Australia is facing the human and animal activities problems in the water catchment area. There have been several activities in the dam area that will give a potential of contamination such as camping, recreational activities, vehicle tracks and cattle. There appears to be of camping occurring next to the reservoir. Camping can cause contamination of surface water through the indiscriminate disposing of rubbish, effluent disposal, clearing and trampling of Bush, and bush fires escaping from camp fires as happened at Moochalabra Catchment Area. Picnicking is incompatible activity in Moochalabra catchment. There are no designated picnic sites in the catchment. However, illegal activity is considered to occur on the reservoir banks, particularly on evenings and weekends, with evidence of fires and litter (Water and Rivers Commission, 2005).

Recreational activities in the dam water catchment include pathogen contamination, wildfire, turbidity, nutrients and inappropriate disposal of rubbish. Pathogens pose the most significant risk to public health. In water supplies, the pathogens of concern that can cause illness such as stomach upset and diarrhoea, is mostly found in the faeces of humans and domestic animals. Human and domestic animal contact with a water body increases the risk to drinking water quality as happened at Mungalup Dam Water Catchment area (Department of Water, 2009). At Moochlabra Dam, cattle access to the reservoir area, although the fence surrounding the dam is in bad condition, there is little circumstantial evidence that the cattle get close to the reservoir. The nature of this ground surface tends to be rocky and rough and the cattle spend their time in the more accessible areas downstream of the dam wall near the King River (Water and Rivers Commission, 2005).

Pathogen contamination of a drinking water source at Kirup Dam is influenced by the existence of pathogen carriers (i.e. humans and animals, such as dogs or cattle) and the opportunity for their subsequent transfer to the water source, the ability of the pathogen to survive in the water source and the concentration level are required to cause illness. Preventing the introduction of pathogens into the water source is the most effective barrier when avoiding risks to public health (Department Of Water, 2007). Pathogens may enter a surface water source through activities involving the direct contact of human and domestic animals with the water body or tributaries (ie illegal fishing, swimming), primarily through the transfer of faecal material, or indirectly through the presence of humans or domestic animals near the water body and its tributaries (ie runoff transferring faecal material). There are a number of pathogens that are commonly known to contaminate water supplies worldwide. These include bacteria (eg *Salmonella*, *Escherichia coli* and *Cholera*), parasites (eg *Cryptosporidium*, *Giardia*) and viruses. The percentage of humans in the world that carry various pathogens varies (Department of Water, 2007).

There have been evidence such as vehicle tracks seen below the high water mark suggests that illegal off-road driving, including trail bikes and motorbikes, occurs within the catchment, particularly on the reservoir banks with access via non-authorised established tracks. Off-road driving is just an incompatible activity within the Dam Catchment Area due to the risk posed through turbidity, presence of people (pathogens) and potential accidents resulting in spills of fuels or oils (Department of Water, 2009). At Brookton Catchment Area, the catchment is dissected to the south by a minor road used for servicing the local farming community. Any spill of fuel or chemical that may result from an accident on this road is not possible to have an impact on catchment water quality because of the vegetation buffers to the reservoir (Department of Water, 2008). What are happened in Selangor, the dam areas are threatened by human activities from the urbanization process or in other word impact from the external factor. Where urban development pattern in Selangor is horizontal development and urban sprawl are spread to the dam area. They have some dam are already surrounded by buildup area. And it is not a good situation for sustainable development. So this study will cover the study of the effects of human activities in term of an external factor, in the dam area and safety. And hope will strengthen the theoretical framework of the relationship between the dam, environment and human activities. Where the dam, environment and human interplay of good and bad affect each other. Or in other words, the reversed relationship. And a description of the theoretical framework of the relationship between the dam, people and the environment will be discussed in the next discussion.

2.4 Previous Study Interactions Dam, Human Being And The Environment in Malaysia

The previous study focused on the impact of the dam development on humans and the environment and the impact of human activities and environmental events on water quality as well as the structure of the dam. The dam impact to the human is done by the study about the Population perception of relocation of Bengoh Dam Settlement Area, Kuching Sarawak, where this study found that the majority of the population supported the relocation proposals due to key factors such as the provision of basic facilities, according to family needs, according to others, the government's demand and had to move because of the absence of land for planting in the old areas. Through this study also, researchers have identified other issues related to relocation such as politics, management, finance, threats and so on, (Angin, 2009). The assessment of the value of compensation for relocation was also reviewed. Compensation valuation for the resettlement of the indigenous communities in Bakun Hydroelectric Dam, Sarawak, showed that gaps in land compensation (differences in expected compensation and actual compensation paid out by state authorities) can result in dissatisfaction towards compensation. Besides that, environmental value (non-use value) perceived by the settlers is found to be significant in affecting probability of dissatisfaction towards compensation. The most important finding is that the lack of freedom and rights of settlers to participate in resettlement processes bring about dissatisfaction towards compensation. This has policy implication for government initiatives on compensation. An institutional avenue to consult and discuss the compensation figures with the settlers should be present to ensure agreeable compensation (Lee, 2014).

Furthermore, research on the impact of dam on the environment in Malaysia is more focused on the impact on the river, especially in relation to water quality and sedimentation. There have a study on Selangor River Water Quality Index (WQI) after the construction of Selangor River Dam has been conducted in 2008. The results show that the overall WQI of Selangor River may be categorized as Class III. However, the downstream part of Selangor River could be categorized as Class IV. With concentrations of BOD and NH4 being the highest reported among the WQI parameters, it can be concluded that Selangor River is in need of an intensive treatment to stabilized its water quality. The degradation of the river water quality could be linked to recent changes in land use within the Selangor River Basin, especially with regard to agricultural activities, urban development and housing schemes. A continuous monitoring process should be implemented to ensure that Sg. Selangor can sustain the various socio-economic activities happening on the downstream part of the river (Jaafar *et al.,* 2009). Study relate to the water quality impact also done with an Assessment of Water Quality of Batang Rajang at Pelagus Area, Sarawak. This results showed that most stations at main river were categorized as slightly polluted while most tributaries were clean according to the Water Quality Index. The river is suffering from organic pollution where almost all stations along the river contained high chemical oxygen demand (≈ 43.1 mg/L) and total ammonia nitrogen (≈ 0.520 mg/L) and were classi ed as Class III and IV at most of the stations. High suspended solids (218.3 mg/L) and low dissolved oxygen (4.6 mg/L) were observed at the main river. The low dissolved oxygen content from the Bakun dam upstream of the study area has an impact on the river particularly during dry season where DO dropped below the minimum required for sensitive aquatic organisms, (Ling *et al.,* 2017).

Further research on the impacts of environmental phenomena on dams is on sedimentation, risk of earth quakes and slides movements. A study on the sediment size distribution and determination of sediment density profile in the selected area of Muda dam catchment area, Kedah. The objective of the study was to establish a base line data of the input sedimentation with regards to the effects of development within the catchment in the future. Three main sampling locations were identified namely at Sungai Teliang, Sungai Muda and Muda reservoir. Measurement of sediment thickness was performed by using nuclear gauges i.e. direct transmission and backscattering methods. Results showed that the grain size distribution of sediment ranges from gravel to clay sizes. In the reservoir and downstream of the river, most of the samples studied consisting of fine sediment i.e silt and clay sizes (<63fim). However, sediment distribution in the upstream section of Sungai Teliang mainly consist of fine to coarse sand. Sediment density profiles in the reservoir showed little changes, whereas bed sediment profiles in the river cross-sectional areas exhibit some changes. The results also showed that thickness of bedload sediment were different from one location to another, in which the thickness may achieve up to 0.75 metre in some areas Based on the sediment distribution profile analysis, the study site could be divided into two parts comprising of dynamic area (region) covering selected locations along the river and deposited sediment in the reservoir. Basic information derived from this study may provide as one of the important imputsfor the MADA reservoir management authority in monitoring, supervising and identifying rate and source of sediment in the catchment area (Kamarudin *et al.,* 1999). Next study about the sedimentation is the study of Sediment balance of the lowland tropical reservoir of Timah Tasoh, Perlis. A study was carried of out to assess the sediment balance of a shallow Timah Tasoh Reservoir (Area: 191 km2). Stream flow gauging and water sampling was carried out at three river inputs to the reservoir, and at the reservoir outlets. River water samplings were carried out every two weeks but frequent and intensive sampling during storm events. The land use in the catchment area ranging from urban area to agriculture, sugar cane, rubber, paddy, rural villages, small towns, quarrying and mining activities. Suspended sediment load data was used to derive the sediment balance. Jarum River (S1), Upper Pelarit River (S2) and Chuchuh River (S3) produced 10,032.3 t; 6,439.2 t; 1,061.4 t of sediment respectively while suspended sediment yield in S1, S2 and S3 were 155.8 tkm-2yr-1, 150.7 tkm-2yr-1, and 71.7 tkm-2yr-1 respectively. Storms play a major role in transporting sediment from the catchment areas. Almost 88.7% of the total suspended sediment yield is transported from S1, 56.7% from S2 and 80.1% from S3. The annual sediment output load at the reservoir outlet was 1 653.0 t. From the total of 17 532.9 t of suspended sediment input to the reservoir, 15 879.9 t was stored in the reservoir. The estimated trapping efficiency of the reservoir is 90.6%. Designing sediment control and management strategies as well as increasing storage elsewhere in the watershed will help reduce the efficiency of sediment delivery from the individual catchment to the river. Alternatively, reductions could also be achieved by reducing sediment output through the construction of wetlands and the use of buffer strips (Rahaman & Ismail, 2013). Beside the sedimentation earthquake risk to the dam structure also has been highlighted in the study of The recent Bukit Tinggi earthquakes and its relationship to major structures. This study present the cause of the recent, small and shallow intraplate earthquakes in the Bukit Tinggi area. The results of the study show that the earthquakes are located at or near to the intersection of three sets of major lineaments trending N-S, NW-SE and NE-SW. This corresponds to the N-S faults, the NW-SE Bukit Tinggi and Kuala Lumpur fault zones and the NE-SW faults, respectively. It is interpreted that the earthquakes are due to the reactivation of the above faults. The fault reactivations are believed to be the result of stress build-up due to the present-day tectonics in SE Asia (Sundaland), especially the oblique, NNE-oriented subduction of the Indo–Australian plate under the Sundaland. The earthquake occurrences indicate that the core of Sundaland is also deforming and that earthquakes do occur in Peninsular Malaysia. It is implied that the intraplate deformation zone associated with the Sumatran Subduction Zone is wide, encompassing Peninsular Malaysia. Hence, it is suggested that the design of large engineering structures in Peninsular Malaysia must take into consideration the possible seismicity due to the reactivation of ancient major faults zones, the seismicity due to tremors from seismic waves generated with epicentres located in Sumatra and rarely, major dam-induced seismicity (Shuib, 2008).

The ancient slide study in dam area are done by the research about Reactivated ancient slides at the Sungai Kelalong Dam site, Bintulu Sarawak, East Malaysia. This study are highligt the occurrence of massive landslide on the spillway slope and part of the neighbouring core trench wall was largely attributed to the intersection of low angle, listric normal fault and the subvertical, E-W striking fault zone. The former is interpreted as a sliding plane of an ancient slide, which probably took place during the Pliocene uplifting in a condition of wet soft sedimentary deformation, to allow for the formation of well-developed normal listric faults system. Reactivation of the ancient slide is caused by the extensive earthworks activities for the dam construction which resulted in massive landslide to the spillway slope. This case study gives clear examples of the importance of geological inspection during the construction stage to check and to detect any structural defects that were not identified in the previous site investigation works (Jamalluddin, 2014).

In Malaysia the dam is also used as a source of freshwater fisheries. There have a study about the function of the dam as a source of Malaysia freshwater fisheries. The study is about the Status of Reservoir Fisheries in Batang Ai Hydroelectric Dam, Sri Aman, Sarawak. Results shows that the average fisheries production in the reservoir range from 17.12 to 20.55 kg ha-1 yr-l. Therefore, proper management of the reservoir should be done to sustain the fisheries production in Batang Ai Hydroelectric Dam, Sarawak (Nazereen & Rosli, 2014).

The impact of human activity on the dam is also explained by the study of The impact of land use in the catchment of Batang Ai and reservoir fisheries on Batang Ai hydro-electric power (HEP) lake. This study explained The lack of farm land at Batang Ai Resettlement Scheme had lead to an increased in the number of resettled communities to come back to utilize their former NCR lands which were not submerged by the construction of the hydro-electric power dam. Increased in population of the area resulted in the increased for land use and water resources utilization. Therefore the objectives of this study were to: (i) record the water quality of the lake in accordance to the INWQS, (ii) examine the existing agriculture and reservoir fishery practices at the lake, and (iii) evaluate changes in fish species at the lake and its tributaries. The water quality of the lake, Batang Engkari, and Batang Ai all falls under Class II of DOE WQI which was categorized as good. Under INWQS classification, it falls into Class I to Class III of INWQS which is good to moderate. The result shows that the water of Batang Ai HEP Lake, Batang Engkari and Batang Ai is still viable to support economic activities at that area. The lake has been utilized to cater for the large scale cage culture activities managed by the some community groups, individuals, and government agencies. This study also found that there were changes in the population of fish species of Batang Ai before and after the construction of the dam. A number of fish species of the former river had disappeared and were being replaced by the introduced species in the lake (Bagat, 2005).

Previous research uses a scientific method of water quality to prove the impact of dam construction on humans and the environment. This study differs from the research method. The scope of this study is greater. It does not focus on detailed studies such as water quality. On the other hand, this study is more about management issues in the larger scope, involving land use conflicts and activities within dam catchment areas that can cause water quality pollution and increased sedimentation.

This research method looks at the broader aspects of the overall management system. Specific aspects such as water quality control will be taken into account in the preparation of specific management plans for each dam. The main focus of this study is to correct and strengthen the existing management system structure to ensure that special elements such as water quality can be maintained by strengthening the land use control system in dam basin area.

2.5 Theoretical Framework On The Relationships Between Dams, Human And The Environment.

The previous study of the reversed impact between included impact of the dam development to the man and environment, impact the environment of the dam and human, also influences human activities to the dam and environment. Can be possible to infer that the relationship among the human, dam and environment is a reversed relationship. Where they influence and give an impact to each other. The complicated of relationship will be discussed as showed in Figure: 2.7.

The flow of the impact is started when human built the dam to respond to their specific need such as a water resource, power resources from hydroelectricity, flood control, drainage and irrigation for agricultural activities and others. After or during the dam structure construction, the environment such as a river system will react to the dam structure and the reaction will provide the dam catchment area or reservoir.

Formation of the reservoir will have an impact on the environment and human beings. Effects on humans is, the transfer of the original peopling of the place, apart from that, it also gave rise to the original population as fishermen lose their livelihood. Impact on the environment. Is present in various forms. Among them, deforestation, flood areas, fragment riverine systems, loss of biological diversity, fish migration block, vector breeding, and lastly disaster from dam failure. This relation is showing the construction of the dam has bi-directional effects on the human and the environment as well.

To prove that the dam, people and the environment have a reversed relationship and influence between each other. We will look into the effects dam development to the environment such as, deforestation, and fish migration block to the human. As an example fish migration barriers will impact the socio-economic. Further than that deforestation or submerged timber tree in water will contribute to the high oxidation and contributed to the increase in greenhouse gases, greenhouse gas emissions linked to warming and global climate change, and eventually the effect go to the human back. This cycle clearly shows humans started the construction of dams to respond to their needs and the impact of that, they are also adversely affected by such actions.

In the other direction of the relationship between dam, people and the environment, the environment also affects the dam and also contributes to the occurrence of dams failure or the dam burst. Where the dam breaks will affect the natural environment and human beings in the form of environmental destruction and loss of life and property. Among the factors ecological factors that assist in the failure of the dam are like, landslide, sedimentation, earthquake, climate change, flood and the overtopping, weather threat and impact of animal and plant to the dams.

Lastly the interaction between the dam, environment and humans can be apparent from the impact of humans on the environment, which also contributed to the dam failure. For example, the pollution generated by human activities such as urbanization will contribute to the global warming phenomenon that related with climate change. Climate change will influence the function of the dam and also caused to catastrophic failure of the dam and the dam burst when the weather changes bring a lot of rainfall resulted in overtopping.

From above three reversed interaction effect between dam, human and environment, this study will track the issues occur in the dam basin in Selangor, by selecting seven major dams in the State of Selangor. Where the state of Selangor is Malaysia's fastest growing, and urbanization also spread rapidly until the area around the dam. Disclosure issues and problems of the influence of human activities on the dam are expected to the human activities that impact directly on the dam that will be explored in this research is as logging, urban spread, water pollution, recreation, illegal fishers, and others. the theoretical framework of the previous study of the dam and the relationship among dam, human and environment can be concluded. That human built the dams to meet their own needed and bring the impact to the environment. Whatever impact direction, whether impact to the dam or environment the impact finally will give an impact to the human life back. This relationship is a complicated and they influence each other in various types of influence. This theory is fulfilled the geographic theory where human activities bring a change to the environment and environment will react and give an impact back the human life.

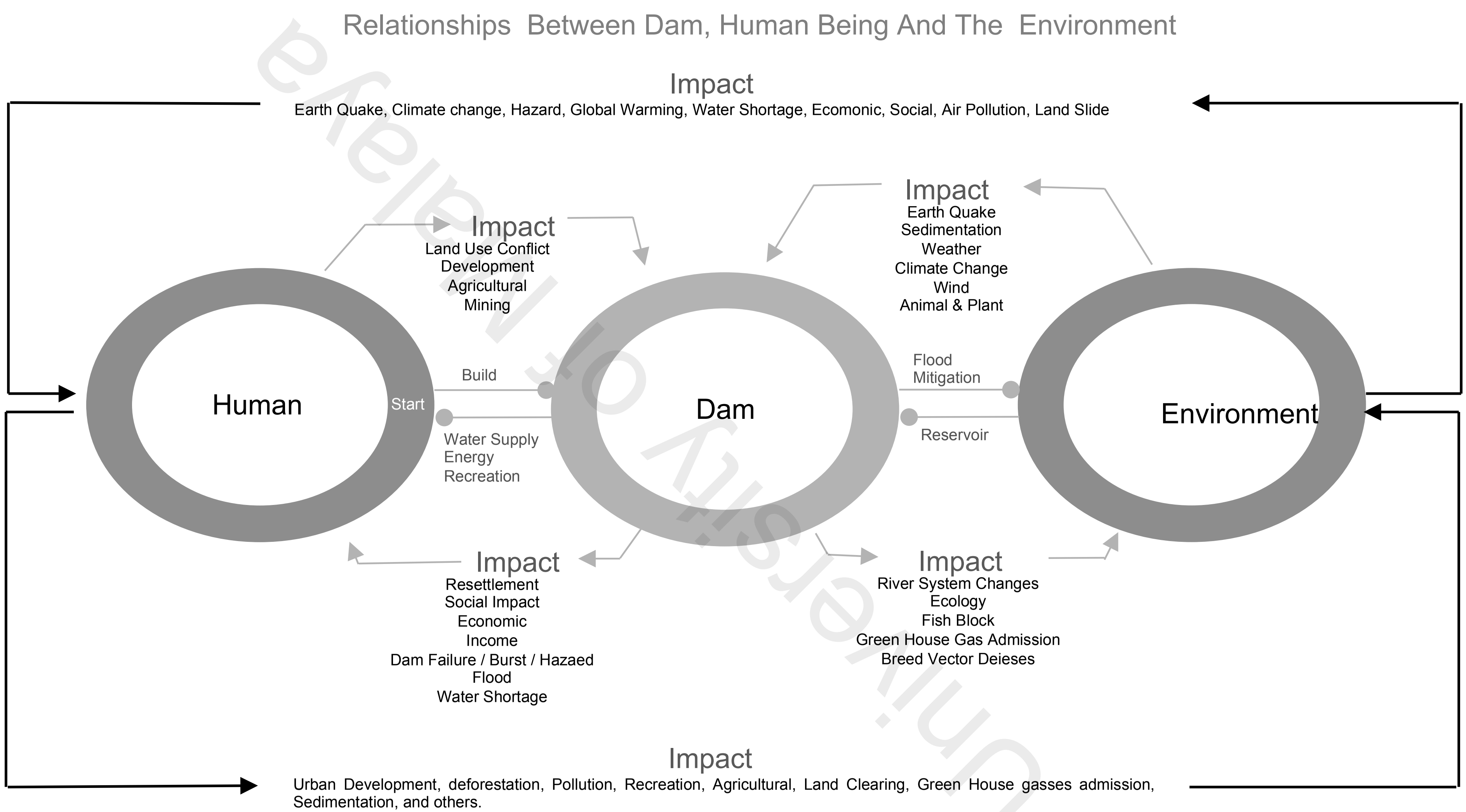


Figure 2.7 : Theoretical Framework On Relationship Between Dams, Human And Environment.

2.6 Land Use Development In The Dam Basin Catchment Area

Typically watershed dams are placed in forest reserves. But there are also some cases of watershed dams are other land use of forest reserves, such as for agriculture, housing and others. Other than that, even though the dam catchment area is forest reserves and state-owned land, there are activities such as cattle, camping activities and so on. As has been the case in most dam catchment area in Australia.

The first case study is in the area Moochalabra Dam catchment. The majority of the Moochalabra Dam catchment is within reserve 16869. The reserve is for water supply purposes. The rest of the catchment is either within reserve 1127, currently vested for Public Utility with the Department of Land Administration (DOLA), or reserve 16729, which is vested with DOLA for the Use and requirements of government. The catchment is mostly native vegetation and has not been developed (Water and Rivers Commission, 2005).

Second Case Study is Quinninup Dam Catchment Area, where, land use and activities in the catchment consist of private land (special residential lots), State Forest and Recreation. In the private land, there is an existing subdivision to the south and south east of Karri Lake (Plate 1). The lots are zoned special residential under the Shire of Manjimup's Town Planning Scheme. Lots range in size from 2000 m^2 to 5500 m^2. A proposal to subdivide Lot 551 (Pt Nelson Loc 13272) is currently at the Department for Planning and Infrastructure awaiting determination. The proposed subdivision has a low yield of 77 lots, with the average lot size being 2163 m^2, ranging from 2000 m^2 to 3920 m2 (Plate 2). On the Crown land, State Forest Number 38 covers the majority of the catchment. The State Forest is exercised by the Conservation Commission of WA, and managed by the Department of Conservation and Land Management (CALM). The forest is managed for multiple use that includes timber production, water production, recreation and nature conservation as well as some apiary use and wildflower and seed harvesting. In the Crown land, there also have the Water Corporation owns Lot 187, which encompasses Karri Lake and the surrounding 30-metre buffer. And lastly the recreation, there is an existing walk trail around Karri Lake that is used for walking, trail bike riding and horse riding predominantly in State forest. Other recreational activities include camping, fishing marooning, and boating and swimming in the lake. Bushwalking, horse riding, 4 wheel driving and trail bike riding occur throughout the catchment mainly along forest tracks. There is no designated camping areas in the catchment. Unauthorised camping occurs at low levels. Recreational hunting for feral pigs also occurs within the catchment area at minimal levels. There are not any restrictions on hunters and their dogs in State Forest, except for prohibition on the use of firearms (Water and Rivers Commission, 2002).

Third case study is Kirup Dam Catchment Area. Where the state forest covers over 87% of the KDCA. The state forest is vested in the Conservation Commission of Western Australia and managed by the Department of Environment and Conservation (DEC) on its behalf and is free from logging. It is therefore proposed becoming a forest conservation area. Land-use activities within the KDCA, that can pose a threat to water quality include recreational activities such as bushwalking, hunting, fishing, marooning and swimming. Other land use activities that are considered a risk to water quality include unregulated off-road vehicle use, feral animals and fires (both fire management and wildfires). There also have a The private land borders the Upper Capel Road, which is a sealed rural access road that passes through the catchment, the parcel of cleared rural private land, representing approximately 13% of the catchment, is located 1.13 km (approximately) upstream of the reservoir.The property is under development for organic horticultural purposes, and contains a variety of orchards, vegetable and herb propagation which may pose a threat to water quality (Department Of Water, 2007).

Forth case study is the Serpentine Dam Catchment Area. Land use and activities in the catchment consist of Land and forest management on Crown land, including timber harvesting, commercial land use such as mining and blue gum plantations and recreation on Crown land. In the commercial land, there is some private land on the south eastern edge of the Serpentine Dam catchment. The area of private land is approximately 1355 ha. Parts of two lots are currently used for Tasmanian blue gum (Eucalyptus globulus) plantations (80 ha), with two private dams and some pasture and remnant native vegetation making up the remainder of the properties within the catchment (130 ha total). Until recently, Sotico owned the majority of the private land in the catchment. Most of this is under native vegetation, with the rest, about 100 ha, managed by Sotico as softwood (pine) timber plantation. A large portion of the property has recently been sold to the Boddington Gold Mine Joint Venture, with Sotico retaining the section utilised for plantation timber production. There is a substantial (~ 50 m) cleared buffer between the pine plantations and the native forest. As part of the proposed Boddington Gold Mine (BGM) expansion near Boddington, some state forest will be disturbed. A condition of environmental approval of the expansion is that BGM will exchange with the Department of Environment and Conservation other areas of land of similar size and conservation value as the state forest to be disturbed. BGM have purchased the land from Sotico with the intent of being used as part of the land exchange. The land will become Crown land administered by the Department of Environment and Conservation once the land exchange is complete. Other commercial land is Waters and Rivers Commission freehold land. The Commission has freehold ownership of several properties in the north-west and south-east of the catchment. These properties would originally have been given to private ownership and have since been reclaimed by the Crown. Those in the southeast are entirely native vegetation and are expected to be incorporated into the Monadnocks National Park (Commonwealth and

Western Australian Regional Forest Agreement Steering Committee (CWARFASC), 1999, Conservation Commission of Western Australia, 2004). The Water Corporation manages the remainder of these properties for the Commission. The properties consist mostly of indigenous vegetation although some parts have previously been cleared. One property in the north of the catchment has had some rehabilitation that has been largely unsuccessful and is subject to illegitimate recreation activities. In the Crown Land State forest and reserves, 664 km^2 Serpentine Dam Catchment Area lies within State Forests number 14 and 67. Within the state forest, jarrah (Eucalyptus marginata) and marri (Corymbia calophylla) forest dominate. Understorey species include Banksia grandis and Allocasuarina fraseriana. In the south-east of the catchment, there is a significant occurrence of wandoo (Eucalyptus wandoo) woodland in the river valleys. A large portion of the forest in the central third of the catchment is designated as a dieback quarantine area. Portions of the state forest are periodically subject to timber harvesting and bauxite mining. The state forest is vested in the Conservation Commission of WA under the Conservation and Land Management Act 1984 (CALM Act) and managed by the Department of Environment and Conservation on the Commission's behalf. State forest is managed for the purposes defined in the Forest Management Plan 2004-2013 as conservation, recreation, timber production, on a sustainable yield basis, water catchment protection and additional purposes prescribed by the regulations. The Forest Management Plan 2004-2013 is a statutory plan for state forests and recognises water catchment protection as a statutory purpose of indigenous state forest and water extraction as a legitimate activity.

A significant area of the Serpentine Pipehead Dam catchment has been incorporated into the Serpentine National Park. This area has one large part of Windsor State Forest Block, east of the Serpentine River, in the centre of the catchment and crossing the boundary into the Canning River Catchment Area. Special Mining Lease, granted to

Alcoa World Alumina - Australia (Alcoa) in 1961, covers part of the Crown land in the catchment. Under the State Agreement Act, Alcoa has rights to extract bauxite from Crown land, with associated responsibilities to protect environmental values and rehabilitate mine sites. All of 129 ha cleared since 1994 have been rehabilitated in Serpentine Dam catchment. Currently mining in the catchment is limited to the Jayrup Trial Mining Area, despite the fact that plans are in place for Alcoa to expand its mining operations in the Serpentine Dam Catchment Area in the future. No mining has been held in Serpentine Pipehead Dam Catchment Area. Alcoa has a comprehensive Environmental Management System which is certified to the ISO14001 standard (White, 2001). Alcoa's operations are supervised by the Mining and Management Program Liaison Group. The Department of Water and the Water Corporation has representation on this group, enabling them to ensure Alcoa meets water quality protection objectives. The Frollett pine plantation is situated in a State forest south of Jarrahdale Rd in the north of the catchment, about 5km from the reservoir. The plantation has an area of about 105 ha (all in Serpentine catchment). Areas of the plantation are harvested when required.

Albany Highway passes through the Serpentine catchment. It skirts along the northeastern border of the catchment, passing into and out of Serpentine catchment twice. Kingsbury Drive skirts along the catchment boundary between Serpentine Dam and Serpentine Pipehead Dam Catchment Areas. Major Western Power transmission line, the Muja Northern Terminal Line, also passes through the catchment. Land and forest management State forest is managed for multiple uses that include timber production, water production, recreation and nature conservation as well as some apiary utilize and wildflower and seed harvesting. There is also widespread collection of firewood for restricted use. Firewood collection is checked by licences issued by the Department of Environment and Conservation. Specific management activities include native forest timber harvesting, plantation timber harvesting and prescribed burning. National Parks and Conservation Parks are not covered by timber harvesting activities, but facilities for recreational use of the forest in National Parks are generally improved or increased (Department Of Water, 2007).

The fifth Case study is the Brookton Reservoir catchment area. The Water Corporation owns approximately 60 per cent of the currently gazette catchment area, which incorporates about 45 per cent of the proposed catchment area boundary, including the majority of land immediately surrounding Brookton Reservoir. 55 per cent of the upper reaches of the catchment is in private ownership and has been approved for agricultural use. The Water Corporation owned Lot 21413 is mainly covered with native vegetation and secured by an internal fence line and gates that prevent access to the water body. However, several tracks still exist within this lot, which is illegally accessed for the collection of firewood and hunting.There is further evidence of swimming in the reservoir. Swimming (and other forms of direct body contact with the water) poses an unacceptable risk of introducing pathogens into the water resource and should not occur in the reservoir. Water birds and ducks are also responsible on the reservoir. It should be pointed out that Lot 21413 is private freehold land owned by the Water Corporation. As such an access to this land (such as for hunting, swimming, fishing or other recreational pursuit) can be subject to Western Australian trespass laws as a control measure. Access to Lot of 21413 is relatively easy as a result of insufficient external fencing surrounding the lot and the presence of multiple tracks and access points. Access to Brookton Reservoir itself and Wabbing Hill Water Transfer Station is somewhat restricted by internal fences and gates, and good native vegetation buffers around the reservoir reduce the threat to water quality. There also has cleared private land is used for low intensity broad acre farming including grazing and cropping. These land uses are typically considered to be a medium pathogen risk to the quality of water within this source. These land practices are separated from the reservoir by forested land on Lot 21413 and the activity levels on the grazing and cropping land is low. Other land uses there is a small amount of Crown land within the catchment set aside as road reserves. The catchment is dissected to the south by a minor road used for servicing the local farming community. Any spill of fuel or chemical that may result from an accident on this road is not possible to have an impact on catchment water quality because of the vegetation buffers to the reservoir. Although the likelihood is minimal, a well prepared and widely distributed emergency response plan (WESTPLAN HAZMAT) needs to be put in place under the responsibility of the regional emergency management district (Department of Water, 2008).

The sixth case study is Mungalup Dam Catchment Area. The Mungalup Dam Catchment Area is located over state forest, which is the responsibility of the Conservation Commission of Western Australia and managed by the Department of Environment and Conservation (DEC) under the Conservation and Land Management Act 1984. There are tracks around the reservoir allowing full access to the water body. Some of these tracks are used by DEC for state forest maintenance and by the Water Corporation for water facility maintenance. Vehicle tracks seen below the high water mark show that the public is given access to the reservoir. Mungalup Road is a sealed public road that passes through the catchment. It is supported in a regular basis. Mungalup Tower Road is a strategic fire access road that is unsealed. Ark Road is also an unsealed road which allows public access right up to the water body. Management measures to address unnecessary use of unsealed roads (e.g. signage or gates) should be deemed to prevent unauthorised public assets around the reservoir. There are no pine plantations in the Mungalup Dam Catchment Area, although timber harvesting has occurred previously in the catchment and may occur again in the future. Public access to some parts of this catchment may be prevented under the Country Areas Water Supply

Act 1947. A mining lease (ML1SA) covers the Mungalup Dam Catchment Area. This state agreement tenement was granted to Alcoa of Australia in 1961. Under the Alumina Refinery Agreement Act 1961, Alcoa has rights to extract bauxite from areas of state forest covered by ML1SA with associated responsibilities to protect environmental values and rehabilitate mine sites. Alcoa has sub-leased part of ML1SA to Worsley Alumina Pty Ltd, containing the part of the lease that covers the Mungalup Dam Catchment Area. Worsley's mining operations are overseen by the Environmental Management Liaison Group, an inter-departmental committee on which the Department of Water is represented to ensure water quality protection objectives are met. No mining activity has occurred in the catchment to date. Native title is a type of land title that recognises the unique ties some Aboriginal groups have to land. Aboriginal title exists where Aboriginal people have maintained a traditional connection to their land and waters since sovereignty, and where Acts of government have not removed it. There is a native title claim within the proposed Mungalup Dam Catchment Area. This is the Gnaala Karla Booja (WAD6274_98) claim (Department of Water, 2009).

From the previous case study about the land issues in dam water catchment area, almost all dam is facing the land use conflict with other land use. Which typically dam water catchment area should only reserve the water catchment area only and have no other land use. Land use issues at dam water catchment area can be concluded as Figure 2.8.

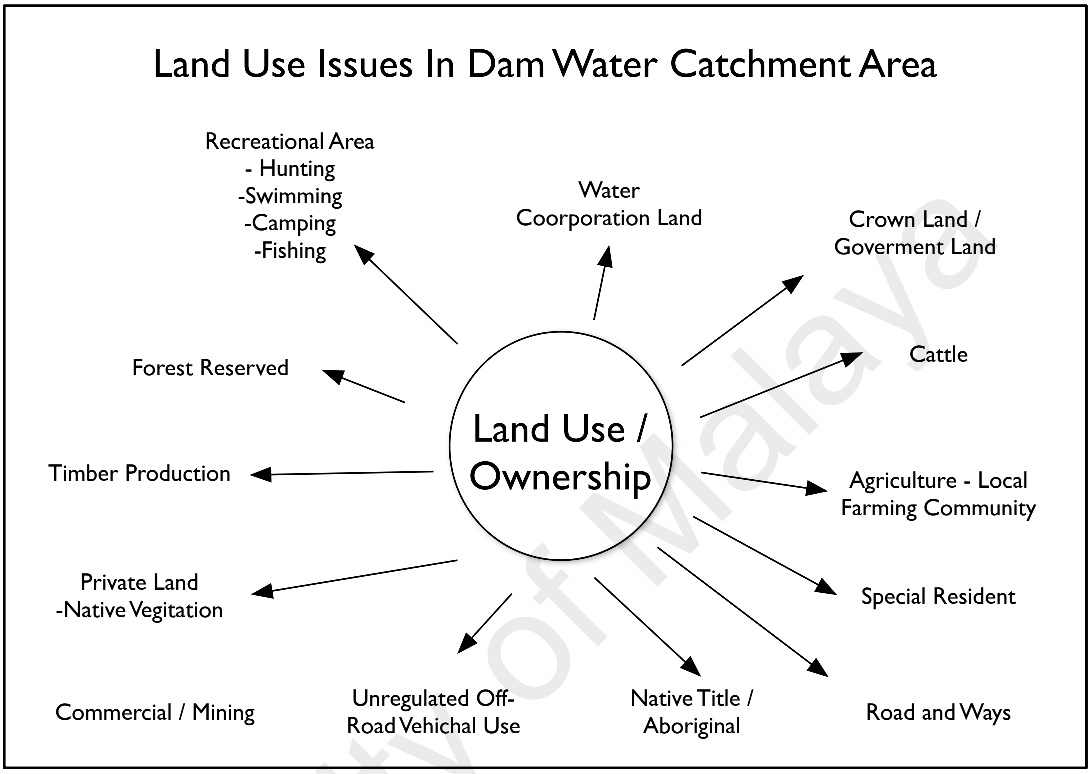


Figure 2.8: Land Issues in Dam Basin Area.

2.7 Overview Of Dam Management Systems.

This part will review the dam administration and management system in other country where this part will be a benchmark to know the strength and weaknesses of the existing dams management system in Selangor and to answer third research objective, To Evaluate The Effectiveness Of Dam Management System In Selangor and it will be discus on discussion chapter. Explanations about the dam administration and management will be in a several country such as an Australia, South Africa, and United State Of America. Before this chapter will review the function and activities of World Commissions On Dams And International Commission On Large Dam (ICOLD).

2.7.1 World Commissions On Dams And International Commission on Large Dams (ICOLD)

The Commission on Dams was a global multi-stakeholder body initiated in 1997 and was created in May 1998. By the mandate from World Bank and World Conservation Union (IUCN) to review the development effectiveness of dams, and to develop standards and guidelines for future dams. They had provide the 10 key on dams management such as: 1) Development needs and objectives should be clearly formulated through an open and participatory process, before various project options are identified; 2) A balanced and comprehensive assessment of all options should be conducted, giving social and environmental aspects the same significance as technical, economic and financial factors; 3) Before a decision is taken to build a new dam, outstanding social and environmental issues from existing dams should be addressed, and the benefits from existing projects should be maximized; 4) All stakeholders should have the opportunity for informed participation in decision-making processes related to large dams through stakeholder for a Public acceptance of all key decisions should be demonstrated. Decisions affecting indigenous peoples should be taken with their free, prior and informed consent; 5) The project should provide entitlements to affected people to improve their livelihoods and ensure that they receive the priority share of project benefits (beyond compensation for their losses); 6) Affected people include communities living downstream of dams and those affected by dam-related infrastructure such as transmission lines and irrigation canals. Affected people should be able to negotiate mutually agreed and legally enforceable agreements to ensure the implementation of mitigation, resettlement and development entitlements; 7) The project should be selected based on a basin-wide assessment of the river ecosystem and an attempt to avoid significant impacts on threatened and endangered species; 8) The project should provide for the release of environmental flows to help maintain downstream ecosystems; 9) Mechanisms to ensure compliance with regulations and negotiated agreements should be developed and budgeted for, compliance mechanisms should be established, and compliance should be subject to independent review, and 10) A dam should not be constructed on a shared river if other riparian States raise an objection that is upheld by an independent panel.

Other than a World Commission On Dams, there are also have a The International Commission on Large Dams (ICOLD), where ICOLD is a non government International Organization which provides a forum as a medium of knowledge and experience exchange in dam engineering, management, planning, development and issues.

2.7.2 Specific Case 1 - Dam Management Systems in The New South Wales (Australia)

In Australia country currently has around 350 prescribed dams and new dams still be constructed (Dam Safety Committee 2010). Regarding the DSC background, Function And Operation Guidelines Report (2010), Historically, each year, there have been several significant dam failures around the world along with many near- failures. Australia though, had an enviable safety record with only one fatal dam failure in Tasmania over eighty years ago, but a number of major Australian dams have suffered safety incidents. The New South Wales Dams Safety Committee (DSC) was constituted by the New South Wales Government under the New South Wales Dams Safety Act 1978 to ensure the safety of dams in New South Wales. The mission of the NSW Dams Safety Committee (DSC) is to assure the safety of dams. The New South Wales Dams Safety Committee (DSC) is a statutory body aligned with New South Wales Trade & Investment. Its function is to assure the safety of dams within the state (Dams Safety Act 1978 No 96, 1978).

Regarding the NSW Dams Safety Act 1978, The Committee shall consist of 9 part-time members appointed by the Minister. The members shall be, (1) a person nominated by Snowy Hydro Limited; (1a) a person nominated by the portfolio Minister under the State Owned Corporations Act 1989 for the electricity generators that are State owned corporations under that Act; (2) a person nominated by the Sydney Catchment Authority constituted under the Sydney Water Catchment Management Act 1998; (3) a person nominated by State Water Corporation constituted under the State Water Corporation Act 2004; (4) a person nominated by the Hunter Water Corporation referred to in the Hunter Water Board (Corporatization) Act 1991; (5) a person nominated by the Minister administering the Public Works Act 1912; (6) 2 persons nominated by the Federal Council of the Institution of Engineers, Australia, and (7). A person nominated by the Minister administering the Mining Act 1992 ("Dams Safety Act 1978 No 96," 1978).

Where, the Minister shall appoint one of the members as chairperson of the Committee. The function of this committee is, (1) to maintain a surveillance of prescribed dams, the environs under, over and surrounding prescribed dams and the waters or other materials impounded by prescribed dams to ensure the safety of prescribed dams; (2) to examine and investigate the location, design, construction, reconstruction, extension, modification, operation and maintenance of prescribed dams, the environs under, over and surrounding prescribed dams and the waters or other materials impounded by prescribed dams; (3) to obtain information and keep records on matters relating to the safety of dams; (4) to formulate measures to ensure the safety of dams; (5) to make such reports or recommendations to the Minister or any other person in relation to the safety of prescribed dams as the Committee considers necessary or appropriate; (6) to make reports and recommendations with respect to the prescription of dams for the purposes of this Act; (7) to exercise such other functions as are conferred or imposed on the Committee by or under this or any other Act or the regulations, and (8). To do such supplemental, incidental and consequential acts as may be necessary or expedient for the exercise of its functions (Dams Safety Act 1978 No 96, 1978).

There have been many guidelines and reference for the dam administration and management are used in the Dams Safety Committee. There have been general guidance; dam guidance and mining guidance are applied in dam administration and management in Australia. The list of general guidance is, (1) DSC Background, Functions and Operations; (2) Background to DSC Risk Policy Context; (3) Dam Safety Management System (SMS); (4) Documentation and Information Flow over Dam Life Cycle; (5) Surveillance Reports for Dams; (6) Demonstration of Safety for Dams; (7) Some Legal Considerations for Dam Owners; (8) Operation and Maintenance for Dams; (9) Emergency Management for Dams, (10) Dam Security, and (11) Community Consultation and Communication (CC&C).

There are also have a guidelines relating and specific to the dam is like, (1) Consequence Categories for Dams; (2) Acceptable Flood Capacity for Dams; (3) Acceptable Earthquake Capacity for Dams; (4) Reliability of Spillway Flow Control Systems; (5) Flood Retarding Basins; (6) Tailings Dams; (7) General Dam Safety Considerations; (8) Embankment Dams (being compiled), and (8) Concrete Dams (being compile).

Apart from that, there are also guidelines on mining activities around the dam area. Include the following, (1) Mining Near Prescribed Dams - Administrative Procedures; (2) Mining Near Prescribed Dams - Mining Applications; (3) Mining Near Prescribed Dams - Management and Monitoring Matters, and (4) Mining Near Prescribed Dams - Contingency Plans. All the guidelines are published in the New South Wales Dam

Safety Committee website for as a guide to public, dams owner and stakeholder is involved in dams (committee).

Other than a Dam Safety Committee, an Australian National Committee On Large Dam incorporated also involves damming management systems in Australia. The Australian National Committee on Large Dams Incorporated (ANCOLD Inc) is an incorporated voluntary association of organizations and individual professionals with an interest in dams in Australia. ANCOLD was founded in 1937 as the Australian national committee of the International Commission on Large Dams (ICOLD), where ICOLD is a non-government organization established in 1928, and is one of 95 member countries. ANCOLD's mission is to be the industry body, representing its members and associates, disseminating knowledge, developing capability and providing guidance to achieve excellence for all aspects of dam engineering, management and associated issues (ANCOLD). ANCOLD also help the DSC in provided the guidance and guidelines in dams administration and management system in Australia such as, (1) Guidelines on Tailings Dams – Planning, Design, Construction, Operation and Closure (May 2012); (2) Guidelines on the Consequence Categories for Dams (October 2012); (3) Guidelines on Risk Assessment (2003); (4) Guidelines on the Environmental Management of Dams (2001); (5) Guidelines on Selection of Acceptable Flood Capacity for Dams (2000); (6) Guidelines on Design of Dams for Earthquake (1998); (7) Guidelines on Strengthening and Raising Concrete Gravity Dams (1992), and (8) Guideline on Concrete Faced Rock fill Dams (1991). All the guidelines are included and the sale of the ANCOLD website.

Based on the literature on various web and report about the dams administration and management system in Australian can be concluded that the Australia have a an effective and comprehensive dam administration and management system where they had provide more guidelines on dam safety management system. And the overall structure of the dam administrations and management systems in Australia see clearly with below figure 2.9: Dam Administration And Management System In New South Wales, Australia.

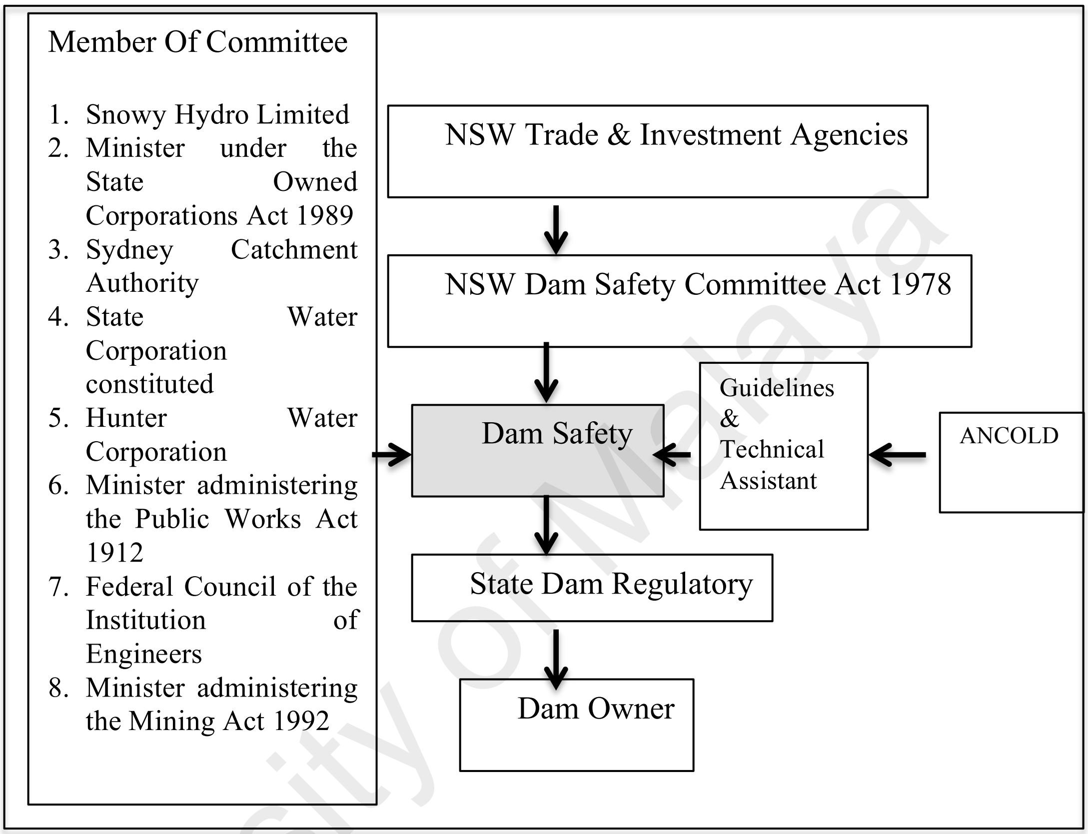


Figure 2.9: Dam Management System in The New South Wales (Australia).

Dam management system in Australia is led by New South Wales, Trade and Investment. Under the NSW Dam Safety Committee Act 1978, they produced the Dam safety committee that will lead, guide and monitor the all-state dam regulatory and dam owner of the dam management system. And besides that Dam Safety Committee, they are helped by the Australian National Commission On Large Dam (ANCOLD) on the technical aspect and they are also had a link with the International Commission On Large Dam (ICOLD).

2.7.3 Specific Case 2 - Dam Management Systems in The United States of America

In the United State Of America, dam administration and management system are lead by the Department of Homeland Security, Federal Emergency Management Agency (FEMA). They do not own or regulate dams, but they are as an administers of the National Dams Safety Program (NDSP). Where NDSP function is to coordinate all federal dam safety programs and assists states in improving their dam safety regulatory programs. The Department of Homeland Security, Infrastructure Protection leads a coordinated national program to reduce risks to the nation's critical infrastructure, including dams, posed by acts of terrorism (National Dam Safety Act, Sec.8, 2000).

Federal agencies are involved with dam safety, either as owners or regulators, include, (1) U.S. Department of Agriculture - Natural Resources Conservation Service and Agriculture Research Service; (2) Department of Defense - Army Corps of Engineers - Engineer Research and Development Center and Hydrologic Engineering Center (HEC); (3) Department of the Interior; (4) Bureau of Indian Affairs; (5) Bureau of Land Management; (6) Bureau of Reclamation; (7) Fish & Wildlife Service; (8) National Park Service; (9) Office of Surface Mining; (10) Federal Energy Regulatory Commission; (11) Mine Safety and Health Administration; (12) International Boundary and Water Commission (U.S. Section); (13) Nuclear Regulatory Commission; (14) Tennessee Valley Authority; (15) NOAA, National Weather Service; (16) U.S. Geological Survey (National Dam Safety Act , Sec.7, 2000)

Where, all agencies are listed above make up the Interagency Committee on Dam Safety (ICODS), and oversaw by FEMA as head of the National Dam Safety Program. This committee is established under U. S. National Dam Safety Program Act. National Dams Safety Program Act Section (8) mentioned ICODS shall encourage the establishment and maintenance of effective Federal and State programs, policies, and guidelines intended to enhance dam safety for the protection of human life and property through, coordination and information exchange among Federal agencies and State dam safety agencies and coordination and information exchange among Federal agencies concerning implementation of the Federal Guidelines for Dam Safety (2000).

Secretary of the Army is acting through the Chief of Engineers, shall carry out a national program of inspection of dams for the purpose of protecting human life and property. All dams in the United States shall be inspected by the Secretary except, dams under the jurisdiction of the Bureau of Reclamation, the Tennessee Valley Authority, or the International Boundary and Water Commission, dams which have been constructed pursuant to licenses issued under the authority of the Federal Power Act, dams which have been inspected within the twelve-month period immediately prior to the enactment of this Act by a State agency and which the Governor of such State requests be excluded from inspection, and dams which the Secretary of the Army determines do not pose any threat to human life or property. In USA, the Secretary of the Army, acting through the Chief of Engineers, may maintain and periodically publish updated information on the inventory of dams in the United States (National Dam Safety Act, Sec.3, 2000).

Under the National Dam Safety Program, FEMA, in consultation with ICODS and State dam safety agencies, and the Board shall establish and maintain, in accordance with this section, a coordinated national dam safety program. They shall achieve the forth objectives to (1) ensure that new and existing dams are safe through the development of technologically and economically feasible programs and procedures for national dam safety hazard reduction; (2) encourage acceptable engineering policies and procedures to be used for dam site investigation, design, construction, operation and maintenance, and emergency preparedness; (3) encourage the establishment and implementation of effective dam safety programs in each State based on State standards; (4) Develop and encourage public awareness projects to increase public acceptance and support of State dam safety programs; (5) develop technical assistance materials for Federal and non-Federal dam safety programs, and (6) to develop mechanisms with which to provide Federal technical assistance for dam safety to the non Federal sector. In this program ICODS should provide The public awareness activity for the education of the public, including State and local officials, in the hazards of dam failure, methods of reducing the adverse consequences of dam failure, and related matters (National Dam Safety Act, Sec.8(c), 2000).

In National Dam Safety Program they have produced many guidelines related to the dam of which are as follows; (1) Guidelines For Public Safety At Hydropower Projects, by Division Of Dam Safety And Inspections Federal Energy Regulatory Commission (2009); (2) Federal Guidelines for Dam Safety Risk Management (Draft); (3) Federal Guidelines for Dam Safety, April 2004; (4) Federal Guidelines for Dam Safety: Earthquake Analyses and Design of Dams Mei, 2005; (5) Federal Guidelines for Dam Safety Emergency Action Planning for Dam Owners , April 2004; (6) Federal Guidelines for Dam Safety: Selecting and Accommodating Inflow Design Floods for Dams, April 2004; (7) Federal Guidelines for Dam Safety: Glossary of Terms, April 2004; (8) Federal Guidelines for Dam Safety: Hazard Potential Classification System for Dams, April 2004, and (9) Emergency Action Planning For State Regulated High-Hazard Potential Dams, Findings, Recommendations, And Strategies, FEMA 608, August, 2007.

Like in Australia, Dam safety program at the U. S. also assisted by the Association Of State Dam Safety Officials (ASDSO). Regarding to the information from ASDSO website, ASDSO was established in 1983. When 39 people were killed by the Kelly Barnes dam failure in Toccoa Falls, Georgia in November 1977. Where on that time, President Jimmy Carter immediately issued an executive order ruling the U.S. Army Corps of Engineers to inspect dams nationwide. In the 3-year "Phase I" program revealed deficiencies in the great majority of non-federal dams. On the heels of the Phase I inspections, two investigations - by the National Academy of Engineering and FEMA - revealed the inadequacy of state dam safety laws and programs. Their reports recommended an interstate forum on dam safety. ASDSO began with organizational meetings in 1983 in Orlando, Florida and Lexington, Kentucky. The first conference, held in 1984 in Denver, attracted nearly 300 attendees and saw the ASDSO constitution and by-laws passed by 34 states. By February 1985, 37 states and Puerto Rico had officially attached to the association. ASDSO's membership stood at 165: 90 Associate (government employees) and 75 affiliate. Today, ASDSO has more than 3,000 members representing state, federal and local governments, academia, dam owners, manufacturers and suppliers, consultants and others, (Association Of State Dam Safety Officials, 2012).

There are greater than 84,000 dams in the U.S., according to the National Inventory of Dams (NID). Base on the above literature and study of the dam administration and management System in United State Of America, shows that they, are a country who has a large amount of dams. Compared to the Australian dam administration and management system U.S. is more complete and comprehensive in all aspects of the dam. As well as they also emphasizing a lot of the authorities, and public awareness role in the dams area conservation and also in a dam safety to the public. The dam administration and management systems in U. S. are shown as figure 2.10: Dam Administration And Management System In United State Of America. Where dams administration and management system in the U.S, are leading by the U. S. Department Of Homeland Security, Federal Emergency Management Agency (FEMA). Under National Dam Safety Act, FEMA as a director, leads an Interagency Committee On Dams Safety, (ICODS). ICODS lead the and guide all the all dam agency included operator, inspector, state regulatory, licensed agency, such as Army Corp, Tennessee.

Where dams administration and management system in the U.S, are leading by the U. S. Department Of Homeland Security, Federal Emergency Management Agency (FEMA). Under National Dam Safety Act, FEMA as a director, leads an Interagency Committee On Dams Safety, (ICODS). ICODS lead the and guide all the all dam agency included operator, inspector, state regulatory, licensed agency, such as Army Corp, Tennessee Valley Authority, Bureau Of Reclamation and other. Where all departments has their own ship and responsibilities to all the dams is under their jurisdiction. Such as Army Corp is responsible to inspect all dam in the U.S. except dam under others agencies and dam which secretary of the army determines does not pose any threat to human life and the property.

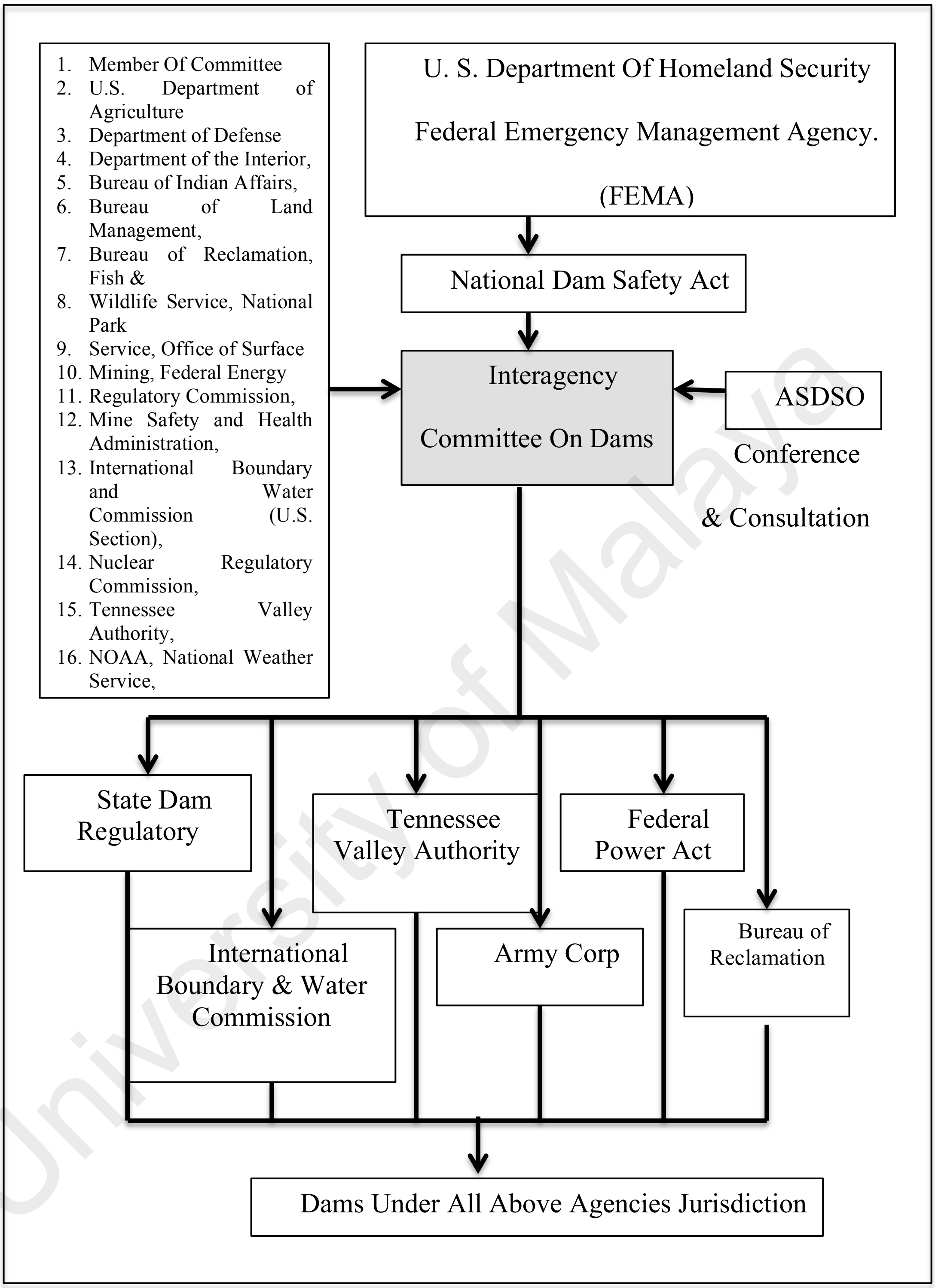


Figure 2.10: Dam Management System in The United State of America.

2.7.4 Specific Case 3 - Dam Management Systems in Canada

Regulation of dams in Canada is a provincial/territorial responsibility and is similar to other areas of provincial jurisdiction such health and education. Unlike other countries, Canada does not have a federal regulatory agency or over-arching program which guides the development of requirements for the safe management of dams. The Canadian Dam Association (CDA), a volunteer organization was formed in the 1980s to provide dam owners, operators, consultants, suppliers and government agencies with a national forum to discuss issues of dam safety in Canada. The Dam Safety Guidelines developed by the CDA can provide regulators with a basis for evaluating the safety of dams within their respective jurisdictions. (Paul *et al.,* 2010).

Table 2.2: Dam safety legislation in Canada

Jurisdiction	Dams	Tailing Dams
British Columbia	Water Act	Healty, Safety and Reclamation Code for Mines in Britidh Colombia
Alberta	Water Act	Water Act
Saskatchewan	Saskatchewan Authority Act	Assessment Act
Manitoba	Water Resources Administration and Water Rights	
Ontario	Lake and River Improvement Act (LRIA)	Mining Act
Quebec	Watercourse Act Dam Safety	Mining Act
New Brunswick	Clean Water Act	
Nova Scotia	Environment Act Regulations	
Newfoundland Labrador	Water Resources Act	Tailings Dams on natural bodies of water fall under Water Resources Act.
Yukon	Water Act (Yukon)	
Parks		
CNSC	Nuclear Safety & Control Act Uranium Mines & Mills Regulation	Nuclear Safety & Control Act General Nuclear Safety & Control Regulations Uranium Mines & Mills Regulation
IJC	1909 Boundary Water Treaty Act	

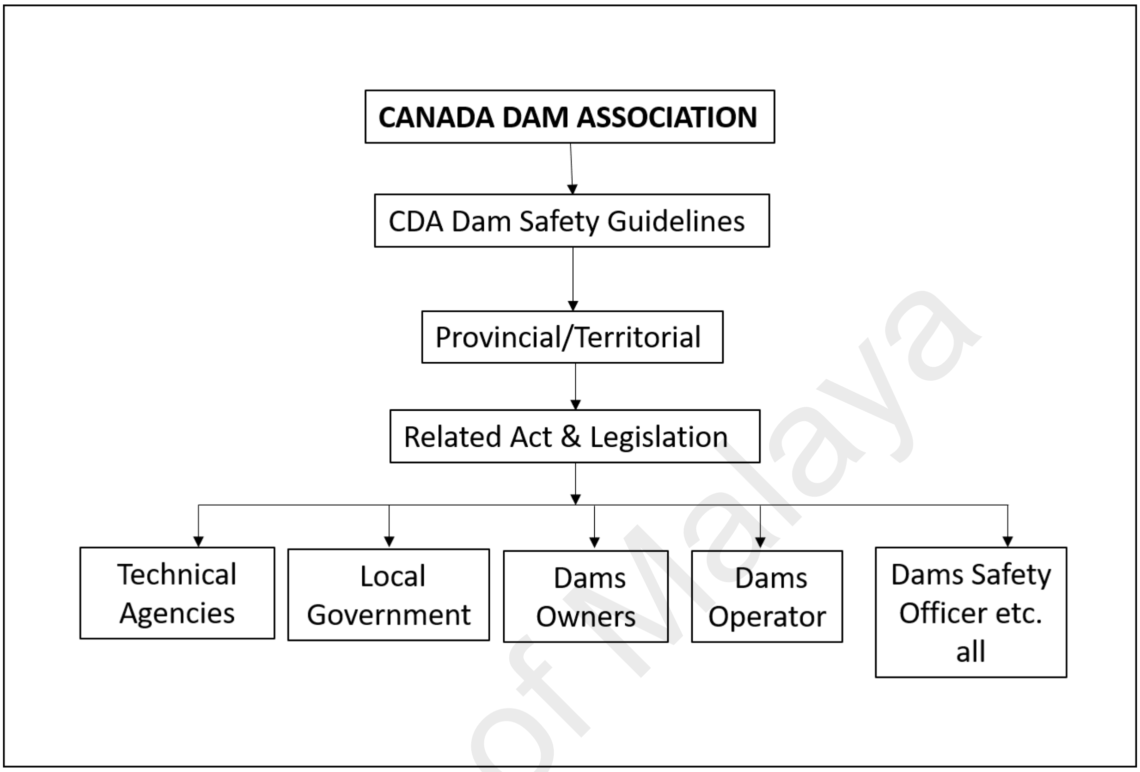
Source : Regulation of Dams and Tailing Dams in Canada. In CDA 2010 Annual Conference

Table 2.2, shows that each provincial/territorial in Canada are having a deference regulation on the dam management. Some are follow a CDA Dam Safety Guidelines and some have their own guidelines. The Water Act of British Colombia 1909, has authority over dams and holds dam owners liable for any damage caused by the construction, operation or failure of their dam. Under the Water Act, dam owners are responsible for; obtaining a water licence and complying with its terms and conditions, and maintaining historical records of all observations, inspections, maintenance items, instrumentation readings, etc. Alberta has Dam Safety legislation as a part of the Water Act and Water Act, Water (Ministerial) Regulations. Part 6 of the regulations is Dam and Canal Safety. The Regulation does not differential dams based on their use. As a result, traditional water course crossing dams and tailings and waste impoundments, not on a water course and created by dams, are regulated by Dam Safety legislation. The Saskatchewan Watershed Authority (the Authority) regulates the development and use of water in Saskatchewan. This Act does not have specific dam safety provisions; however, any person wishing to construct and operate a dam must first obtain approval under The Act from the Authority. The Ontario Lakes & Rivers Improvement Act (LRIA) and Ontario Regulation 454/96 require that the location and plans and specifications for dam works be approved by the Ministry of Natural Resources (MNR). Under the LRIA, the MNR must approve the location and plans and specifications for dam construction, alterations, improvements and repairs. The Act gives the Minister the right to inspect a dam and order an owner to change the reservoir water level, prepare a management plan for the operation and maintenance of a dam or remove an unauthorized dam (Paul *et al.,* 2010).

The objectives of publishing the CDA Dam Safety Guidelines in 1995 was to provide a basis for development of provincial dam safety legislation and regulations. This objective was repeated in the revised 1999 CDA Guidelines. None of the provinces has adopted the CDA Guidelines in their dam safety regulations, although there are references to aspects of the Guidelines. In the current 2007 CDA Guidelines, a number of principles are outlined under five broad topics: Dam Safety Management; Operation, Maintenance and Surveillance; Emergency Preparedness; Dam Safety Review and Analysis & Assessment. None of these principles address the development of provincial dam safety legislation and regulations. However, in 2004 the Dam Safety Regulators Committee was formed to provide guidance to the CDA Board of Directors and act as the resource on items regarding the legislation governing dams. The CDA has supported the advancement of provincial and territorial regulations for dam safety through this committee. To date, no province or territory explicitly references the CDA Dam Safety Guidelines within its legislation or regulations. The Guidelines are frequently referenced in working documents and regional guidelines and standards of practice and/or parts of the Guidelines explicitly written into the legislation and regulation, but not named as CDA Guidelines. Existing legislation in Canada is primarily based on a due-diligence approach. Outcomes and performance measures are defined and the owner must prove that the dam meets the regulated outcomes. The regulator defines what must be met, not How to meet the outcome. This approach is only successful with knowledgeable and diligent dam owners and operators. IT is on this framework that the CDA Dam Safety Guidelines were initiated and continue to evolve for the dam industry in Canada (Paul *et al*., 2010).

The dam management system in Canada are provincial/territorial implement. There is no federal dam monitoring and a specific dam safety Act in Canada. The regulation related to the dam are provided by The Canadian Dam Association (CDA) with publishing the CDA Dam Safety Guidelines. This guideline is suggested to implement by all province and dam owner see figure 2.11.

Figure 2.11: Dam Management System in Canada.



To date, no province or territory explicitly references the CDA Dam Safety Guidelines within its legislation or regulations. There are also have no structured administration and management systems and resources of power by a government specific to the Dam Safety. CDA have no right or power of enforcement to make sure all dams owner to comply the CDA Dam Safety Guidelines. This situation are same with Malaysia Dam but the deference is Canada have a Dam Association namely CDA and Malaysia until now have no any association related to the dam. There have only committee that not enforceable by any law.   Towards a sustainable dam management systems in Canada the Federal Dam Safety Act must be provide to make sure the CDA Dam Safety Guidelines are implement in all province or territory in Canada.

2.8 Issues and Challenges Of Dam Management System.

The top issues and problems in dam management system are included 1) Lack Of Financing Maintenance, Upgrade and Repair. 2) Lack of Adequate Authority and Resources for State Dam Safety Programs. 3) Lack of Public Awareness.

2.8.1 Lack Of Financing for Maintenance, Upgrade and Repair.

Regarding to ADSO By United State of America, lack of funding for dam upgrades is a serious national problem. Operation, maintenance, and rehabilitation of dams can range in cost from the low thousands to millions, and responsibility for these expenses lies with owners, many of whom cannot pay these costs. Dam Management in Malaysia is also facing the same problems. At present, dam maintenance, surveillance and restoration, works depend on the initiative and responsibilities of the parties designated to perform such task. With limited capability, no agency that performs control and supervision task. In view of all these, there is a need for action enacted to ensure all dams owner carry out the standardized and comprehensive maintenance, surveillance and restoration work for their respective dams (Hasnul Salleh, 2006).

2.8.2 Lack of Adequate Authority and Resources for State Dam Safety Program

In US, States are in charge of oversight of the vast majority of dams listed in the National Inventory of Dams (77% in 2012). Although most states have legislative authority to conduct a comprehensive dam safety program, many are lacking in specific areas. Some states are unable, by explicit language in their law, to regulate certain types of dams, allowing these structures to fall between the regulatory cracks. Other states have limited ability to apply the law. In some states, officials have no recourse if dam owners do not carry out safety repairs ordered by the state (ADSO). In Malaysia, there has a Malaysia Inter-Department Committee (MIDC) on safety of dam structured. Was formed in 1986. However, this committee no longer played that role in 1988. This committee has issued a document entitled Guidelines For Operation, Maintenance and Surveillance of Dams. However, it is merely a guideline that is not enforced by law (Hasnul Salleh, 2006).

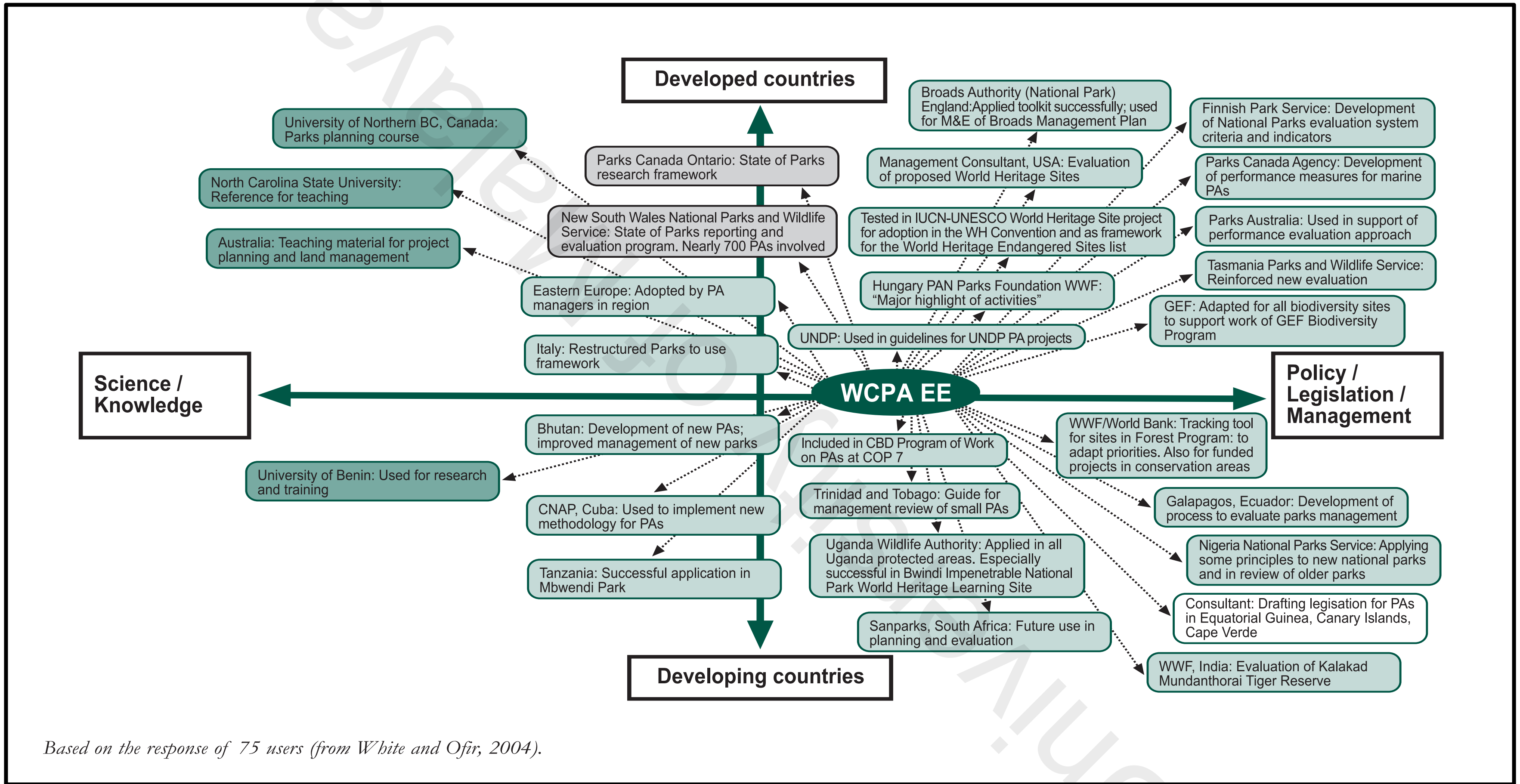
2.8.3 Lack of Public Awareness

There is still an alarming lack of public support and education about the need for proper maintenance and repair of the dam. Unless a dam fails, dam safety is generally not in the public view. Although it is an issue that affects the safety of thousand of people who could be living and working in the path of sudden, deadly dam failure (Hasnul Salleh, 2006).

2.9 Management Effectiveness Evaluation Framework

Since dam basin are become a protected area, this research will take the management effectiveness evaluation in the contact of protected area management. Management Effectiveness Evaluation of protected area is the assessment of how well an area is being manage – looking at design issues; the adequacy and appropriateness of management systems and process; and the delivery of protected area objective including the conservation of value, (Sue, 2006).

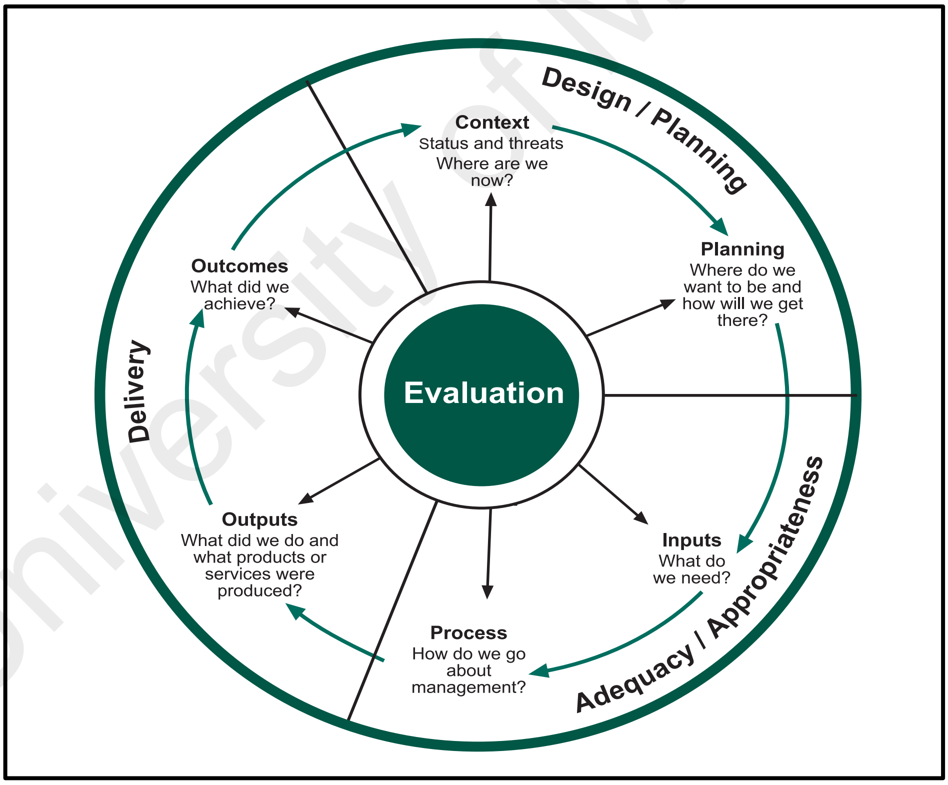
About the last 20 years, a broad range of frameworks (tools) for measuring management effectiveness of protected areas have been prepared. The World Commission on Protected Areas provides an overarching framework for assessing management effectiveness of both protected areas and protected area systems, to provide guidance to managers and others and to help harmonize assessment around the world. IUCN-WCPA Management Effectiveness Evaluation Framework is a system for designing protected area management effectiveness evaluations based around six elements: context, planning, inputs, processes, outputs and outcomes. It is not a methodology, but is a guide to developing assessment systems (IUCN, 2006). There have multiple tool of effective evaluation already developed by IUCN group (see Figure 2.12). After 6 years of implementations, the effectiveness evaluation are divided into three main grouping in the world. 1st is detailed site-level, 2nd quicker site-level and 3rd is a specifically. Detailed site-level assessments aimed at building monitoring systems and long-term understanding of management in an individual protected area, such as the Enhancing our Heritage system being developed for World Heritage sites (see Case Study IV, and also Case Study I for an adaptation of the system for marine protected areas) ; quicker site-level systems built around questionnaires or scoring, aimed at being applied in multiple sites, such as the World Bank/WWF tracking tool (described in Case Study VI) and a related version developed for marine protected areas and specifically is for use on a system-wide scale such as the WWF RAPPAM system and the systems developed in Finland, Catalonia (Spain) and New South Wales (Australia) (IUNC, 2006).



Resource : Evaluating Effectiveness : A Framework for Assessing Management Effectiveness of Protected Areas 2nd Edition, The World Conservation Union, (IUCN).

Figure 2.12: Use of World Conservation Protected Area (WCPA) Evaluating Effectiveness, Across The World.

There have six elements in management cycle as proposed by IUCN. It's begins with understanding the context of the protected area, including its values, the threats that it faces and opportunities available, its stakeholders, and the management and political environment; second is progresses through planning: establishing vision, goals, objectives and strategies to conserve values and reduce threats; third is allocates inputs (resources) of staff, money and equipment to work towards the objectives; fort is implements management actions according to accepted processes; fifth is eventually produces outputs (goods and services, which should usually be outlined in management plans and work plans) and six is that result in impacts or outcomes, hopefully achieving defined goals and objectives. All six elements are shown in Figure 2.13.



Resource : Evaluating Effectiveness : A Framework for Assessing Management Effectiveness of Protected Areas 2nd Edition, The World Conservation Union, (IUCN).

Figure 2.13: The Framework For Assessing Management Effectiveness of Protected Area.

Table 2.3 contains a very brief summary of the elements of the WCPA Framework and the criteria that can be assessed.

Table 2.3: Summary Of The WCPA Framework

Elements of evaluation	Explanation	Criteria that are assessed	Focus of evaluation
Context	***Where are we now?*** Assessment of importance, threats and policy environment	- Significance - Threats - Vulnerability - National context - Partners	Status
Planning	***Where do we want to be?*** Assessment of protected area design and planning	- Protected area legislation and policy - Protected area system design - Reserve design - Management planning	Appropriateness
Inputs	***What do we need?*** Assessment of resources needed to carry out management	- Resourcing of agency - Resourcing of site	Resources
Processes	***How do we go about it?*** Assessment of the way in which management is conducted	- Suitability of management processes	Efficiency and appropriateness
Outputs	***What were the results?*** Assessment of the implementation of management programmes and actions; delivery of products and services	- Results of management actions - Services and products	Effectiveness
Outcomes	***What did we achieve?*** Assessment of the outcomes and the extent to which they achieved objectives	- Impacts: effects of management in relation to objectives	Effectiveness and appropriateness

Source : Worlds Bank (WWF)

From a several tool and methodology to evaluate the management effectiveness base on the IUCN Management Effectiveness For Protected Area Framework. Where Table 2.4: presents an overview of the indicators of to be measured during the evaluation process, METT framework from World Bank are most suitable for evaluate the dam management systems effectiveness. The World Bank (WWF) Management

Effectiveness Tracking Tool has been designed to fulfil the elements of evaluation included in the Framework that will be use in this study with 50% of adjustment to make it suitable to evaluate the effectiveness of dam management system in State of Selangor.

Table 2.4: Presents an Overview of the Indicators

Methodology	Abbreviation	No. of assessment with the methodology
Rapid Assessment and Prioritization of Protected Area Management	RAPPAM	939
Management Effectiveness Tracking Tool	METT	865
New South Wales State of Parks (Australia)	NSW SOP	639
Monitoring Important Bird Areas	BirdLife	506
PROARCA/CAPAS scorecard evaluation	PROARCA/CAPAS	483
TNC Parks in Peril Site Consolidation Scorecard	PiP SCSC	300
Victoria's State of Parks	Victorian SOP	102
AEMAPPS: PAME with Social Participation-Colombia	AEMAPPS	89
Parks profiles	Parks profiles	62

Source : Evaluating Management Effectiveness of National Parks as a Contribution to Good Governance and Social Learning

This study will take a sample set of METT questions as a guide to assess the management of dams in Selangor. However, the scope and survey methods are different. This study will focus on the scope of dam management for the entire country, and methods of survey is through interviews with Agencies, who lead the management of dams in Selangor.

2.10 Sustainable Dam Management System by World Commission on Dams

The last theoretical framework subject is the sustainable Dam Management System will be discussed and answer the fourth research objective, To Identify the Appropriate Sustainable Dam Management System By Selangor. A comparison of sustainable dam management system with the third research objective result about the strength and weaknesses will be discussed on the discussion of the fourth research objective to help this study to achieve the research is intended to find the chance of improvement and enhancement in dams management system in Selangor towards sustainable dams management system. Sustainability of dam involves consideration of engineering, environmental, social, economics, and financial aspect of each, in decisions making process and within the project itself. Once decisions about building the dam have been made. In practice, the environment, social, and decisions making aspect of dams are usually less well understood and addressed then their engineering and financial aspect. Any discussions on sustainability of large water resources infrastructure project should focus on developing a comprehensive, understanding of these issues and the incorporations of this understanding in to local normative framework and actual practices (Dams et al., 2007). Toward a sustainable dam management systems, World Commission On Dam has, sets out this constructive and innovative way forward for decision making in to the dam and water resources management in the form of the seven strategic priorities. (1) Gaining Public Acceptance; (2) Comprehensive Options Assessment; (3) Addressing Existing Dams; (4) Sustaining Rivers and Livelihoods; (5) Recognizing Entitlements and Sharing Benefits; (6) Ensuring Compliance, and (7) Sharing Rivers for Peace, Development And security, as showed on figure 2.14: The World Commission Dam's seven strategic priorities towards a sustainable Dam Management System, (Dams, 2000).

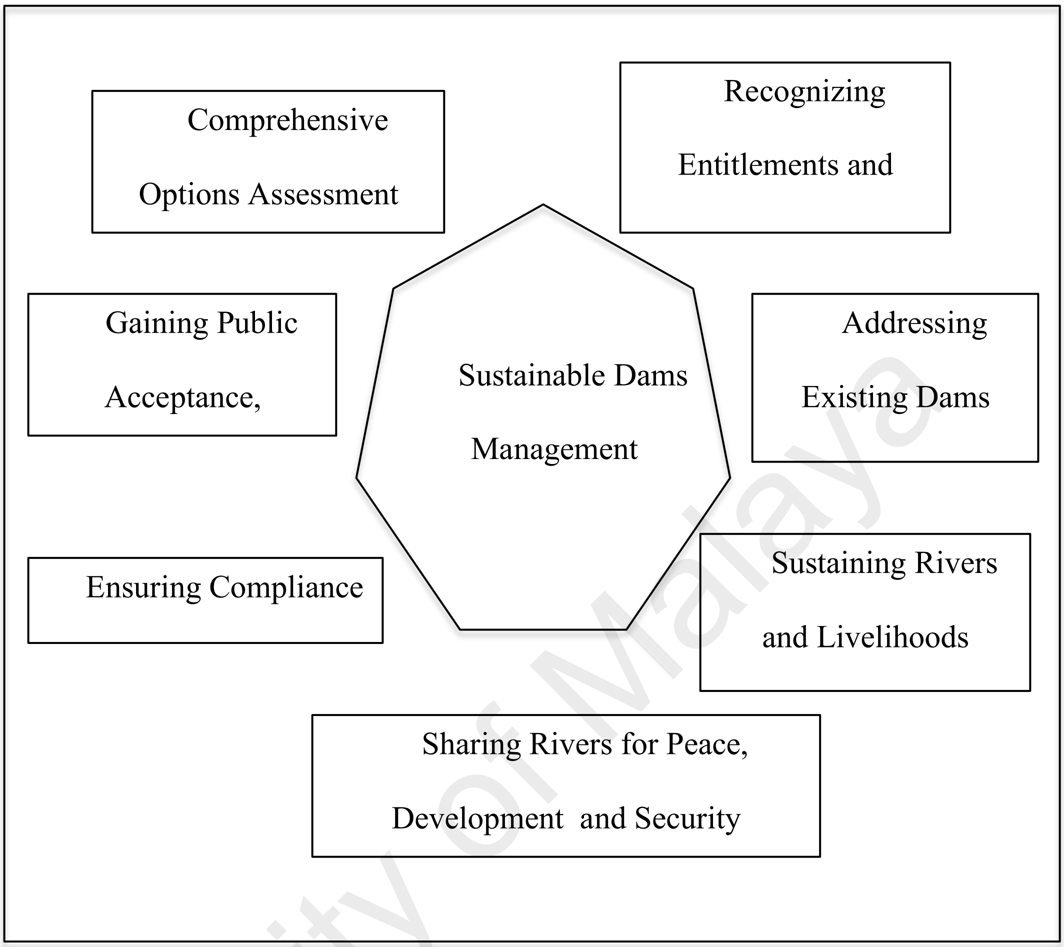


Figure 2.14: The World Commission Dam's seven strategic priorities Towards a Sustainable Dam Management Systems.

Why Gaining Public Acceptance, Public acceptance of key decisions is essential for equitable and sustainable water and energy resources development. Acceptance emerges from recognizing rights, addressing risks, and safeguarding the entitlements of all groups of affected people, particularly indigenous and tribal peoples, women and other vulnerable groups. Decision-making processes and mechanisms are used that enable informed participation by all groups of people, and result in the demonstrable acceptance of key decisions. The projects affect indigenous and tribal peoples such processes are guided by their free, prior and informed consent, (Dams, 2000, pp.215).

Comprehensive Options Assessment is Alternatives to dams do often exist. To explore these alternatives, needs for water, food and energy are assessed and objectives clearly defined. The appropriate development response is identified from a range of possible options. The selection is based on a comprehensive and participatory assessment of the full range of policy, institutional, and technical options. In the assessment process social and environmental aspects have the same significance as economic and financial factors. The options assessment process continues through all stages of planning, project development and operations. (Dams, 2000. pp.221).

Third Thirds Strategies is Addressing Existing Dams. Opportunities exist to optimize benefits from many existing dams, address outstanding social issues and strengthen environmental mitigation and restoration measures. Dams and the context in which they operate are not seen as static over time. Changes in water use priorities, physical and land use changes in the river basin, technological developments, and changes in public policy expressed in environment, safety, and economic and technical regulations may transform benefits and impacts. Management and operation practices must adapt continuously to changing circumstances over the project's life and must address outstanding social issues, (Dams, 2000. pp.225).

Sustaining Rivers and Livelihoods. Rivers, watersheds and aquatic ecosystems are the biological engines of the planet. They are the basis for life and the livelihoods of local communities. Dams transform landscapes and create risks of irreversible impacts. Understanding, protecting and restoring ecosystems at river basin level is essential to foster equitable human development and the welfare of all species. Options assessment and decision-making around river development priorities the avoidance of impacts, followed by the minimizations and mitigation of harm to the health and integrity of the river system. Avoiding impacts through good site selection and project design is a priority. Releasing tailor-made environmental flows can help maintain downstream ecosystems and the communities that depend on them, (Dams, 2000, pp.234).

Recognizing Entitlements and Sharing Benefits. Joint negotiations with adversely affected people result in mutually agreed and legally enforceable mitigation and development provisions. These provisions recognize entitlements that improve livelihoods and quality of life, and affected people are beneficiaries of the project. Successful mitigation, resettlement and development are fundamental commitments and responsibilities of the State and the developer. They bear the onus to satisfy all affected people that moving from their current context and resources will improve their livelihoods. Accountability of responsible parties to agreed mitigation, resettlement and development provisions are ensured through legal means, such as contracts, and through accessible legal recourse at national and international level, (Dams, 2000, pp.240).

Ensuring Compliance is to ensuring public trust and confidence requires that governments, developers, regulators and operators meet all commitments made for the planning, implementation and operation of dams. Compliance with applicable regulations, criteria and guidelines, and project specific negotiated agreements is secured at all critical stages in project planning and implementation. A set of mutually reinforcing incentives and mechanisms is required for social, environmental and technical measures. These should involve an appropriate mix of regulatory and non-regulatory measures, incorporating incentives and sanctions. Regulatory and compliance frameworks use incentives and sanctions to ensure effectiveness where flexibility is needed to accommodate changing circumstances, (Dams, 2000, pp.244).

Last strategic policies in sustainable dams management system are, Sharing Rivers for Peace, Development and Security. Storage and diversion of water on trans boundary rivers has been a source of considerable tension between countries and within countries.

As specific interventions for diverting water, dams require constructive co-operation. Consequently, the use and management of resources increasingly becomes the subject of agreement between States to promote mutual self-interest for regional cooperation and peaceful collaboration. This leads to a shift in focus from the narrow approach of allocating a finite resource to the sharing of rivers and their associated benefits in which States are innovative in defining the scope of issues for discus- scion. External financing agencies support the principles of good faith negotiations between riparian States, (Dams, 2000, pp.251).

All seven strategies above are have listed policies that will be discus and compared with existing dam management system in Selangor to answer the research objective for in this research. The comparison will be highlight detail on result and interpretation chapter.

2.11 The Research Working Model

Previously all discussion on review of literature is come out with one working model for this research. There have been four keywords words structure of the theoretical model for this study. 1st is dams, 2nd is issues, 3rd is challenges and 4th is Evaluation and 5th is Sustainable Dam Management System (See Figure 2.15).

Dam characteristic it's included the type function, size category and disaster class. There have four type of dam such as embankment, arch, buttress and gravity. In function category, the have several function of the dam in world such as, fisheries, flood control, hydroelectricity, irrigation, navigation, recreation, water supply and others. Meanwhile, the dam disaster class is divided in to three levels. It's High, Significant and Low level. The dam size category is divided in to big and small category.

Issues are related to the dam is involved in the issues of the impact of dam development on the human and environment. There is also influence of Environment and Human to the dam basin and structure. All listed issues, showing that's between dam, human and environment the have a reversed interaction. It's started with human develop the dam to meet their own need. Development of the dam will lead to the environmental and social changes. But all the previous studies about the issues on the dam are more on impact of development of the dam to the environment especially the river system. Second famous issues related to the dam are the impact of dam development to the human settlement, socially and economically.

The third key word structure is challenges. From review of literature, the challenges in the existing dam management system are showing by the structure of existing dam management system and the problems are happened in existing dam management system. The existing dam management system in the world will involved the Dam Safety Act, Guidelines, Manual for Operators and all related agencies, Research

Institute, Professional Board Related to the dam, Strategic Plan, Maintenance, Administration, Enforcement, and Plant and Animal factor. Meanwhile, the problems happened in the existing dam management system are the lack of financing for maintenance, upgrade and repair, lack of adequate authority and resources for dam safety programs, and the main one is the lack of public awareness.

The ford keyword is tool of management to evaluate the existing dam management system and to identify the strategy to improve the existing dam management system. By referring World Conservation Protected Area – IUCN frameworks, there has a eight tool to evaluate the management system that has been used across the world.

For the last keyword is Sustainable Dam Management system. The World Commission On Dam Already set up the 7 core strategic priorities toward an implementation of sustainable dam management systems (see figure 2.15).

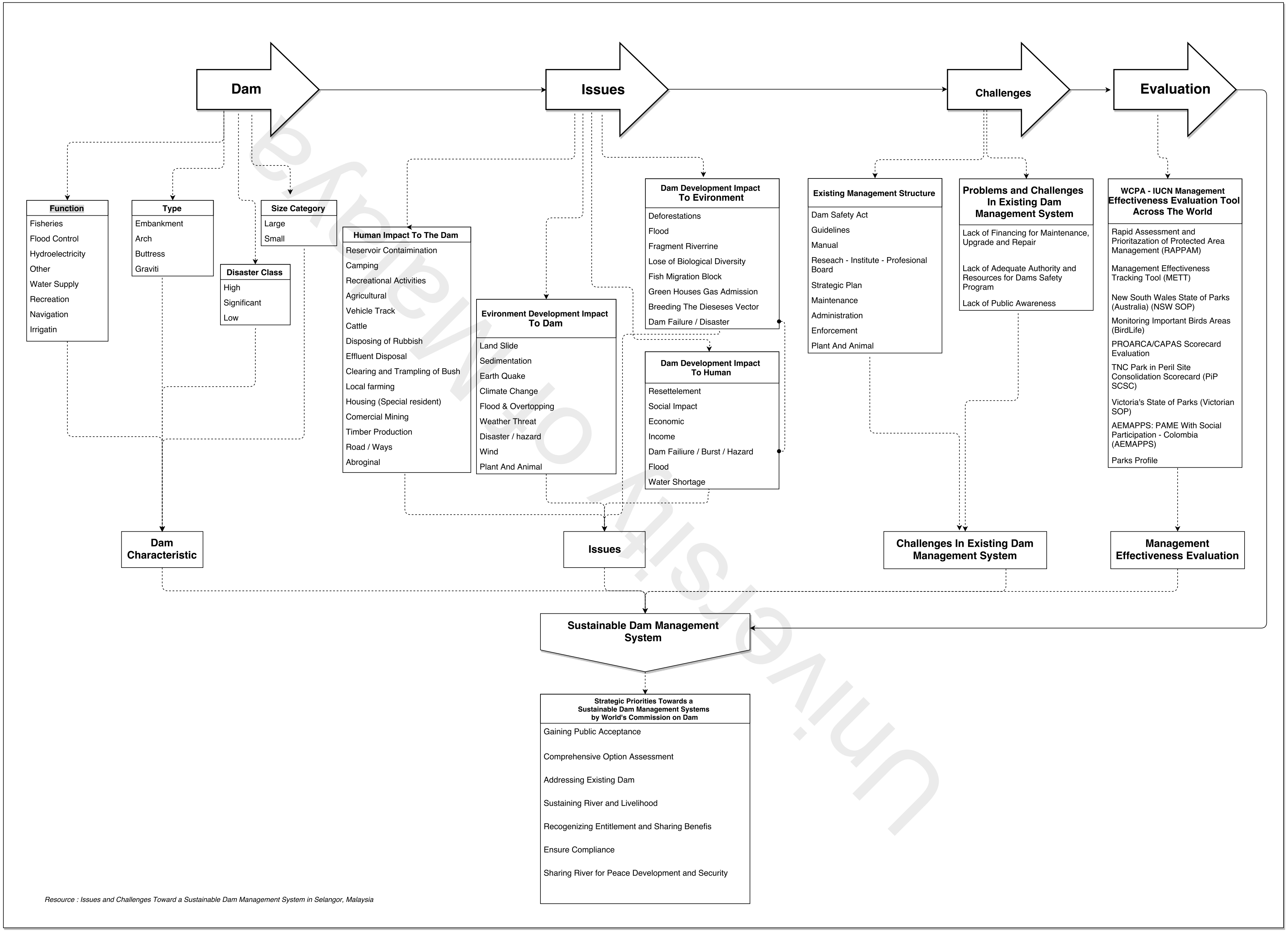


Figure 2.15: Research Working Model

2.12 Conclusion

Previous research uses a scientific method of water quality to prove the impact of dam construction on humans and the environment. This study differs from the research method. The scope of this study is greater. It does not focus on detailed studies such as water quality. On the other hand, this study is more about management issues in the larger scope, involving land use conflicts and activities within dam catchment areas that can cause water quality pollution and increased sedimentation.

This research method looks at the broader aspects of the overall management system. Specific aspects such as water quality control will be taken into account in the preparation of specific management plans for each dam. The main focus of this study is to correct and strengthen the existing management system structure to ensure that special elements such as water quality can be maintained by strengthening the land use control system in dam basin area.

The law and the source of enforcement and administration in the management system need to be strengthened first. Without strong laws and management systems, the scientific studies undertaken by previous researchers, are merely a study only and enforcement cannot be implemented based on the findings and studies that have been made. This will also involve wastage to the country's revenue, as many funds and allocations have been channeled into research.

However, in identifying the major issues of land use conflicts and activities within the dam area in Selangor, this study also carried out the methods that were undertaken by previous studies, such as site visit visits, interviews and other relevant official document.

In addition to the larger scope, the difference in the method of this study with the previous study was spatial analysis. This study has mapped activities within the dam area and analyzed data on land use and land ownership within the dam catchment area.

CHAPTER 3: DATA ACQUISITION AND ANALYSIS

3.1 Introduction

The research methodology is an important aspect of research to make a study results are good and reliable. Research methodology also provides guidance and step-by-step method of bringing out a more systematic research. Research is a logical and systematic search for new and useful information on a particular topic. It is an investigation of seeking solutions to scientific and social problems through objective and systematic analysis. It is a search for knowledge, to discover the hidden truths. Research knowledge means information about matters. The information might be collected from different sources like experience, human beings, books, journals, nature, etc. A research can lead to additional contributions to the existing knowledge. Only through research is impossible to make progress in a field. Research is done with the help of study, experiments, observation, analysis, comparison and reasoning, (Rajasekar *et al.,* 2006).

This study also carried out the methods that were undertaken by previous studies such as site visit visits, interviews, other relevant official document and management effectiveness evaluation tool across the world by World Conservation Union (IUCN). In addition to the larger scope, the difference in the method of this study with the previous study was spatial analysis. This study has mapped activities within the dam area and analyzed data on land use and land ownership within the dam catchment area.

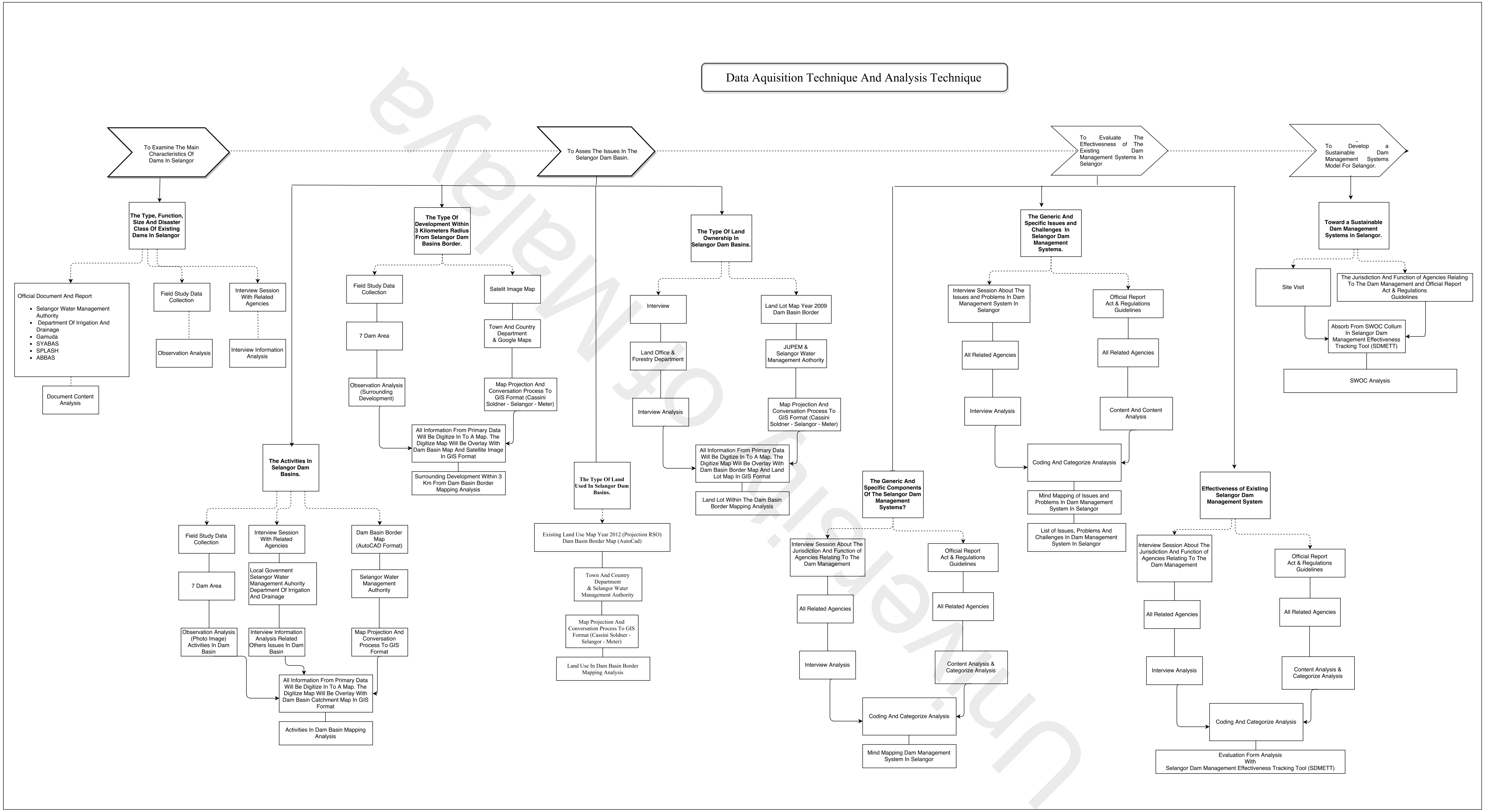
This chapter will describe the research methodology used in order to complete this study. The method are used in this study are described according to the research objectives of the division to four and nine sub- chapter review questions through the literature review.

First sub chapter is The Characteristic of Dams in Selangor. Under this sub- chapter the identify research technique that will be used to obtain information on the type, function, size and disaster class of the dams in Selangor.

2nd sub chapter is The Issues in The Selangor Dam Basins. This sub-chapter will explain the detail technique to get the information about the type of activities, land use, type of development and the type of land ownership in Selangor dam basins

On 3rd sub-chapter, will be discuss about the technique to get the information about The Existing Dam Management Systems in Selangor. The technique will divide in to three techniques which is the information about the generic and specific components of The Selangor Dam Management Systems and the generic, specific issues and challenges in Selangor Dam Management Systems and the effectiveness tracking tool to evaluate the existing dam management systems in Selangor.

4th sub-chapter is a sustainable dam management systems model for Selangor. This sub-chapter will explain detail about the SWOC analysis technique to develop a sustainable dam management system model for Selangor. An overview of the research methods used in this study is described in the figure 3.1.



Resources : Issues and Challenges Toward a Sustainable Dam Management System in Selangor, Malaysia

Figure 3.1 : Research Design and Analysis Technique

3.2 The Characteristic of Dams in Selangor

Research design will be identified and decided through the research question. Each research question will have deference research design and sometime have a multiple of technic in the way to answer the research question. Research design will be discussed by the research question.

3.2.1 The Type, Function, Size and Disaster Class of Existing Dams in Selangor

Base on figure 3.2, has several research designs to get the information about type, function and disaster class of an existing dam in Selangor. Overall type of research design is qualitative research. To gather the data, this study need a, site visit or study field in the dam area to identify the type function, and the view of the dams. Second technic is being use is document review the official report of the dam in Selangor especially about the technical part such as a capacity, height, disaster class, structure, stability and others. So this research question will utilize two technic of research. 1) Is primary data from the study field in year 2012 and 2) from the secondary data from the official report of the dam in Selangor of Drainage and Irrigation Department and Selangor Water Management Authority. The Analysis will be use is, context and summarize the analysis on a term of type, function, size categories and disaster class of the dam in Selangor to be discussed with theoretical frameworks for dam definition and Characteristic in chapter 6 - discussion.

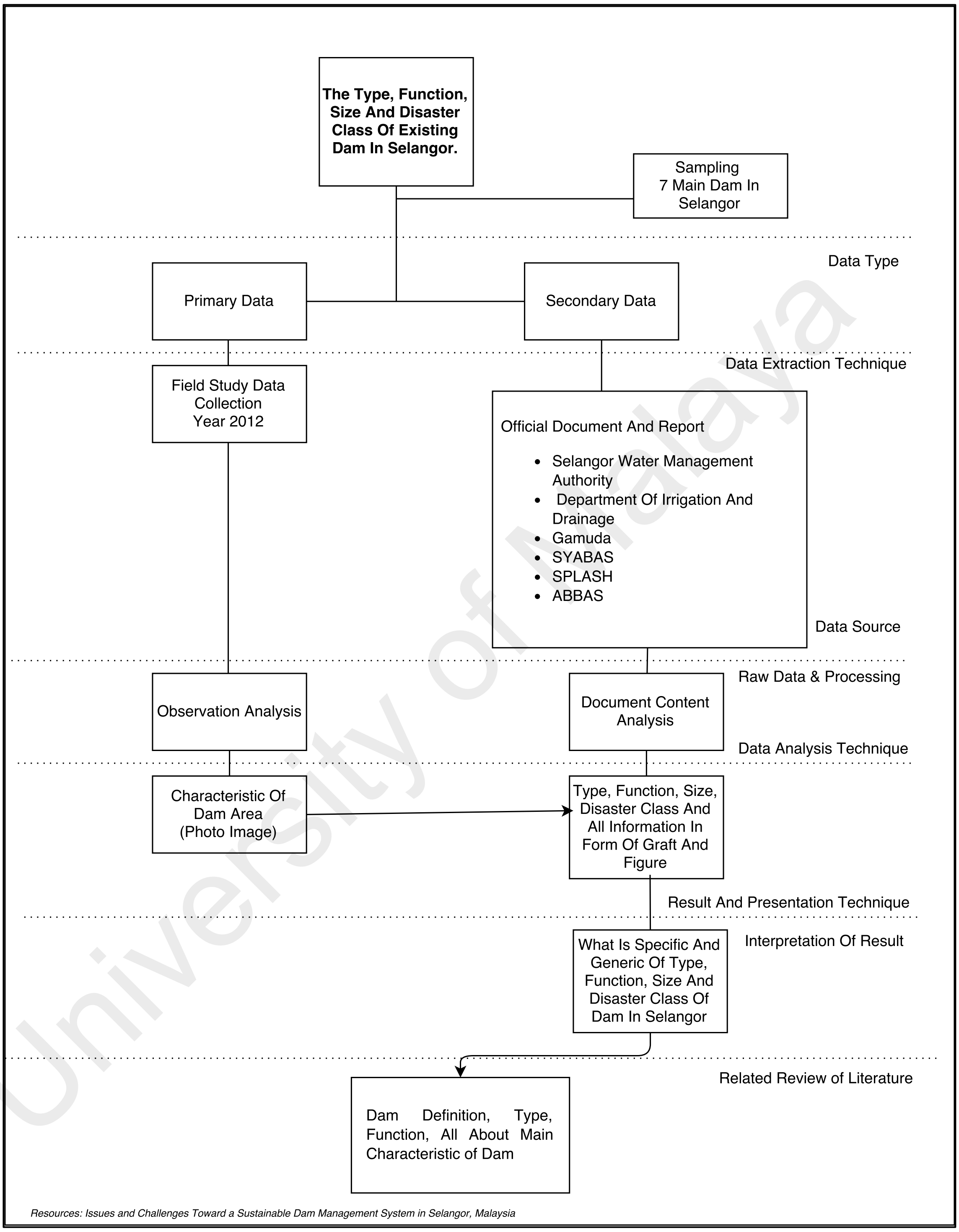


Figure 3.2 : Data Acquisition Process - The Type, Function, Size and Disaster Class of Existing Dam in Selangor

3.3 The Issues In Selangor Dam Basins

3.3.1 The Type Of Activities In Selangor Dam Basins

To know the activities in the dam basin in Selangor, this study are used the quantitative research to identify the activities in dam area in Selangor. Field study has been use to look and find what the problems happened such as illegal dumping problem in dam area or interference are happened at dam area, the field study data are digitized in the map form, to look and analyze the location of interference at the dam area see Figure 3.3. Second technic are used is the interview session with officers from related agencies in dam management and development surrounding the dams. The related agencies as, Selangor State Water Management Authority, State Land Department, Drainage and Irrigation Department, Town and Country Planning Department, all local government are involved, and operator such as SYABAS, ABBAS, SPLASH, National Security Council and others are related. All the data from the interview session and the mapping analysis and field study has been analyze with qualitative data analysis technic. Results presentation and interpretation are form of Interference issues at dam water catchment area map, listing of issues and problems from the interview session and comparison analysis result about which dam is facing the issues of interference.

3.3.1.1 Comparative Analysis

In the main of assessments, from 9 type of activities from mapping analysis, each with a three-point scale. The intention is that the scale shows whether the situation is acceptable or not. Generally 1 is low; 2 are medium and 3 are high of activities. A series of three alternative answers are provided against each activity in dam basin to help make a judgment as to level of score given. The score is totaled and the percentage of the possible score calculated. The maximum score of 8 is 384. (8) type, of activity multiply with the highest total location (16) and multiply with (3) point-scale. A final total of scores from completing the assessment form can be calculated as percentage of

384 or of the total score from all types of interference issues were relevant to the particular dam water catchment area. Percentage earned by each dam water catchment area will be classified into several ranking of interference issues.

The four point scoring system are used is generally 0 is equivalent to not significant of interference issues; 0.1 - 25 is low; 25.1 - 50 is medium and 50.1 - 100 are a high level of interference issues. Dam basin or dam water catchment area is a level 1 sensitive environmental area in a Malaysia National Physical Plan 3, there is no activity are allowed in the dam basin area excluded the research activity. Water quality is must maintained between class 1 and 2 in accordance with interim water quality standards. Any timber activity should be 100 meters wide form the dam water catchment buffer zone. Because of the high level of sensitivity, this area should not be exposed to activities that could threaten the water quality and dam area security. With that, this research makes an assumption, that the score is over 50% it is a high level of interference to the dam area. 50% of score can harm and exposed the dam basin area to the water pollution, sedimentation, rubbish and others. In addition, any activity within the dam basin area such as oil spill, leachate for rubbish, landslide and any pollution will affect the reservoir water quality. Medium level is half of 50%, which mean it is a within 26% to 50%. Low level of interference is between 1% to 25% and 0% is not significant of interference.

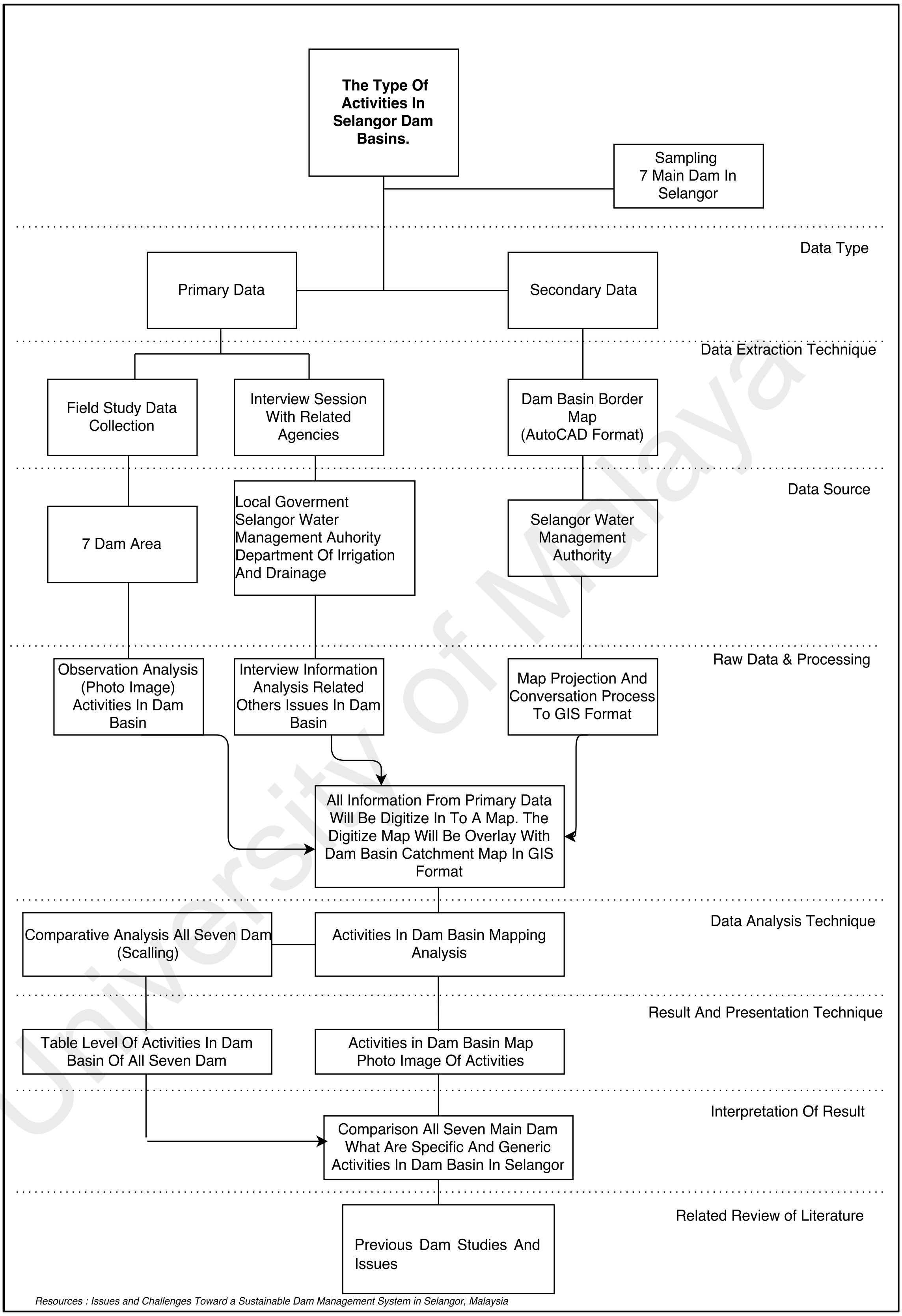


Figure 3.3 : Data Acquisition Process - The Type Of Activities In Selangor Dam Basins

3.3.2 The Type of Development Within 3 kilometer Radius from Selangor Dam Basins Border

To get the type of physical landscape within a 3 kilometers radius from dam basin border in Selangor, this study will use the quantitative research, to identify the dam water catchment surrounding development within 3 kilometers from the dam's structure, with study field as a primary data. Second technic is secondary data from the mapping data from satellite image map from Town And Country Planning Department (Sungai Tinggi Dam, Batu Dam, Klang Gate Dam, Langat Dam and Semenyih Dam) and Google image from Google Maps (Tasek Subang Dam and Sungai Selangor Dam area). The analysis that will use is observation analysis and mapping analysis. This map will be overlaid with dam water catchment border maps from SWMA and buffer within 3 kilometers from the dam water catchment border by generated from buffer tool in MapInfo software. Comparative analysis will be made between the seven main dam to look which dam are surrounded by the urban area, new development or located far from the urban area, see figure 3.4. The trend of development in Selangor are tent to approaches and surrounds the dam water catchment boundaries especially the old dam structure such as Tasek Subang Dam, Batu Dam and Klang Gate Dam. Dam basin or dam water catchment area is a level 1 sensitive environmental area in a Malaysia National Physical Plan 3, there is no activity are allowed in the dam basin area excluded the research activity. This data analysis, also to look either the dam near to the urban area are facing the interference and land use conflict at the end of the research (discussion chapter 6).

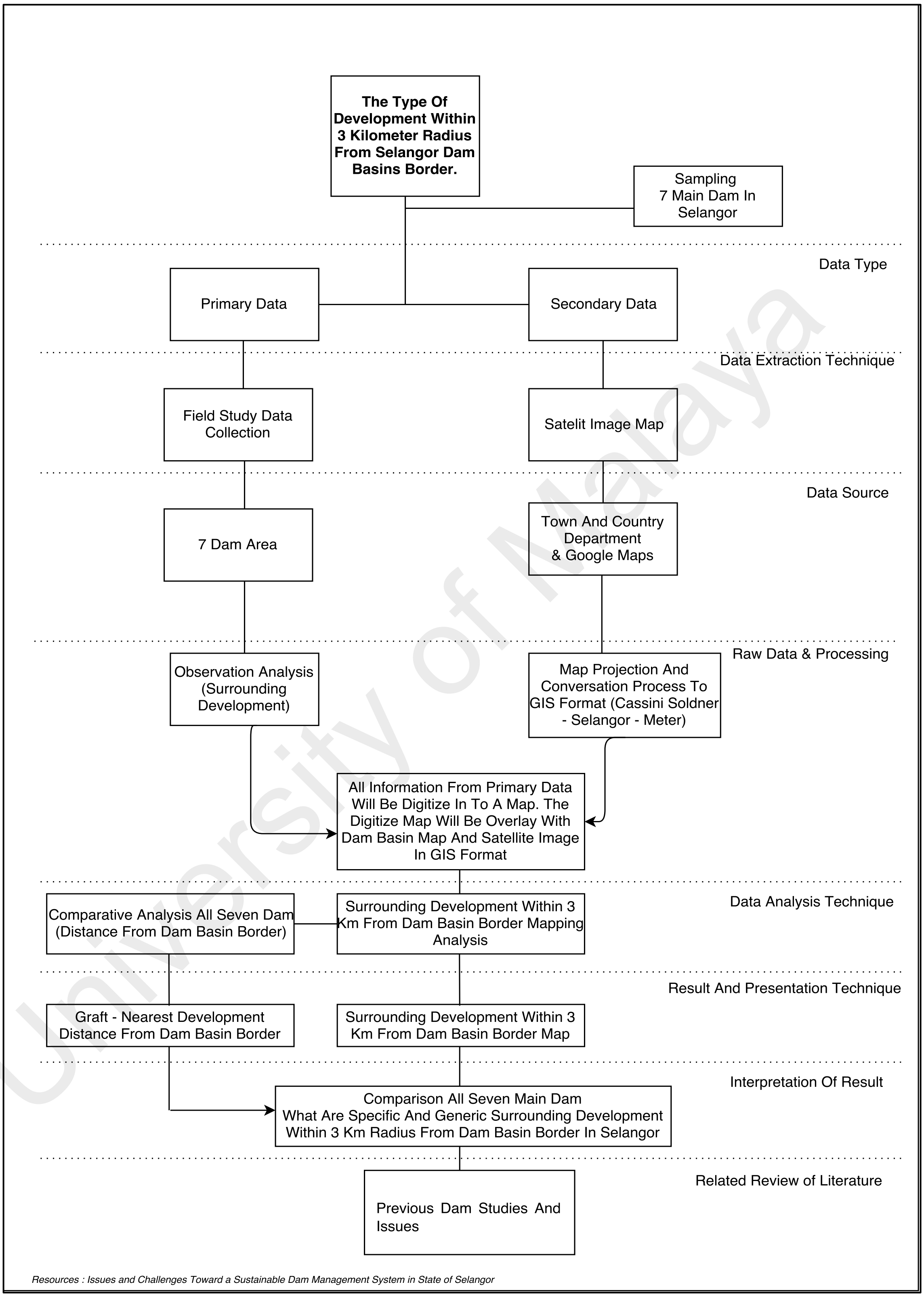


Figure 3.4 : Data Acquisition Process - The Type of Development Within 3 Kilometer Radius From Selangor Dam Basins Border

3.3.3 The Type of Land Use in Selangor Dam Basins.

Type of land use in the dam basin in Selangor will involve two analytical techniques as figure 3.5.

3.3.3.1 Mapping Analysis

Mapping analysis technique used to identify the land use conflict in dam water catchment area. Data acquisition technique is done by secondary data from Planning Approval information are digitized as a map. Planning approval and Land Use information can be got from Selangor State Town and Country Department. Second map data is water catchment border maps from LUAS. Two types of maps come from deference agencies will be overlaid and analyzed. Conducted mapping analysis to know the existing land use in the the dam's water area.

3.3.3.2 Comparative Analysis

Comparative analysis between seven main dams has been made to identify which dam are facing the land use conflict and which dam are not having a land use conflict in dam water catchment area. In the main of assessment, from 6 type of land use, each type with a sixt-point scale. The intention is that the scale shows the level of impact brings by each contradict land use. Generally 0 is equivalent to forest and water body; 1 is agriculture; 2 is residential; 3 is business; 4 is road / ways and 5 is industries. A series of five alternative answers are provided against each land use type to help make a judgment as to level of scale given. The total of scale will be multiplied with the total of land use area percentage. The score is totaled and the percentage of the possible score calculated. The maximum score of 6 types of land use is 25 multiply 100% (percentage area from total of dam water catchment area) become 2500. A final total of scores from completing the assessment form can be calculated as percentage of 2500 or with the total score from those type of land use was relevant to the particular dam water catchment area. Percentage earned by each dam water catchment area will be categorized into the ranking of land use conflicts. Generally 0 is equivalent to not significant of land use conflict ; 1 - 25 is low; 26 - 50 is medium and 51 - 100 are a high level of land use conflict. Dam basin or dam water catchment area is a level 1 sensitive environmental area in a Malaysia National Physical Plan 3, there is no contradict land use with the forest and water body are allowed. Water quality is must maintained between class 1 and 2 in accordance with interim water quality standards. Others land use will lead to the a lot of activities in the dam basin area. Because of the high level of sensitivity, this area should not be exposed to others land use that could threaten the water quality and dam area security. An assumption, makes the score is over 50% it is a high level of land use conflict to the dam basin area. 50% of score can harm and exposed the dam basin area to the water pollution, sedimentation, rubbish and others. In addition, any activity within the dam basin area such as oil spill, leachate for rubbish, landslide and any pollution from others land use will affect the reservoir water quality. Medium level is half of 50%, which mean it is a within 26% to 50%. Low level of land use conflict is between 1% to 25% and 0% is not significant of land use conflict.

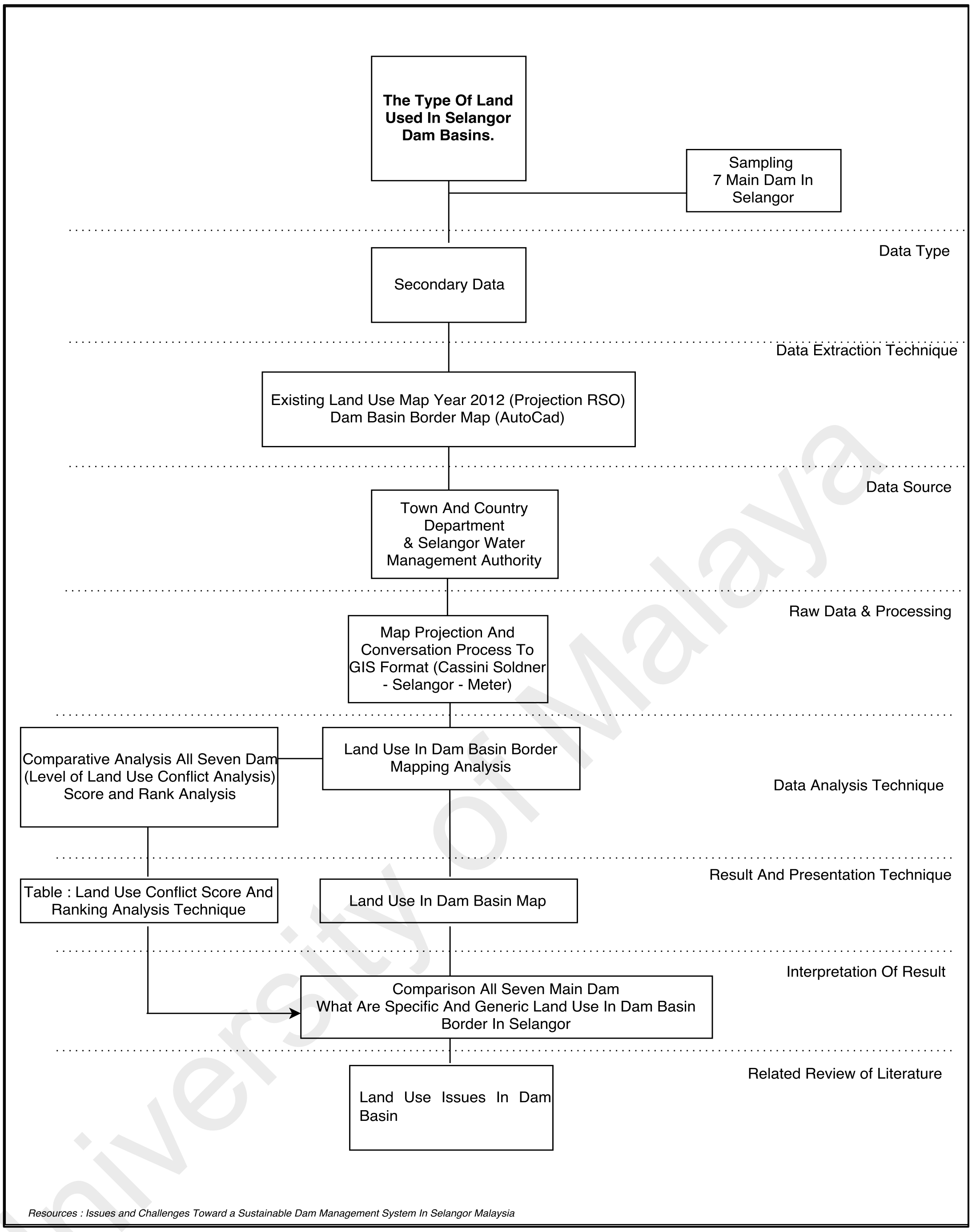


Figure 3.5 : Data Acquisition Process - The Type Of Land Use In Selangor Dam Basins

3.3.4 The Type of Land Ownership in Selangor Dam Basins

To get the information about the type of land ownership in the dam basin in Selangor, analysis technique involved is mapping and comparative analysis.

3.3.4.1 Mapping Analysis

Mapping analysis will be implemented, to identify the land lot in dam basinarea. Land title lot is meant by ownership of the land by private. The data acquisition technique is by secondary data of Land Title Lot Maps year 2009 from JUPEM. Second map data are water catchment border maps from LUAS. Two types of maps come from deference agencies will be overlaid and analyzed in mapping analysis to know the existing land title lot or the ownership land in the dam's water catchment area. Comparative analysis between seven main dams will be made to know which dam have a lot of private land lot and which dam have a less private land lot in the dam water catchment, see Figure 3.6.

3.3.4.2 Comparative Analysis

This technique will make a comparison with a percentage of private land in dam water catchment area. Percentage earned by each dam water catchment area will be categorized into the ranking of private land ownership in dam water catchment area. Generally 0 is equivalent to not significant of private land; 0.001 - 33 is low; 34- 66 is medium conflict and 67- 100 are a high level of private land percentage.

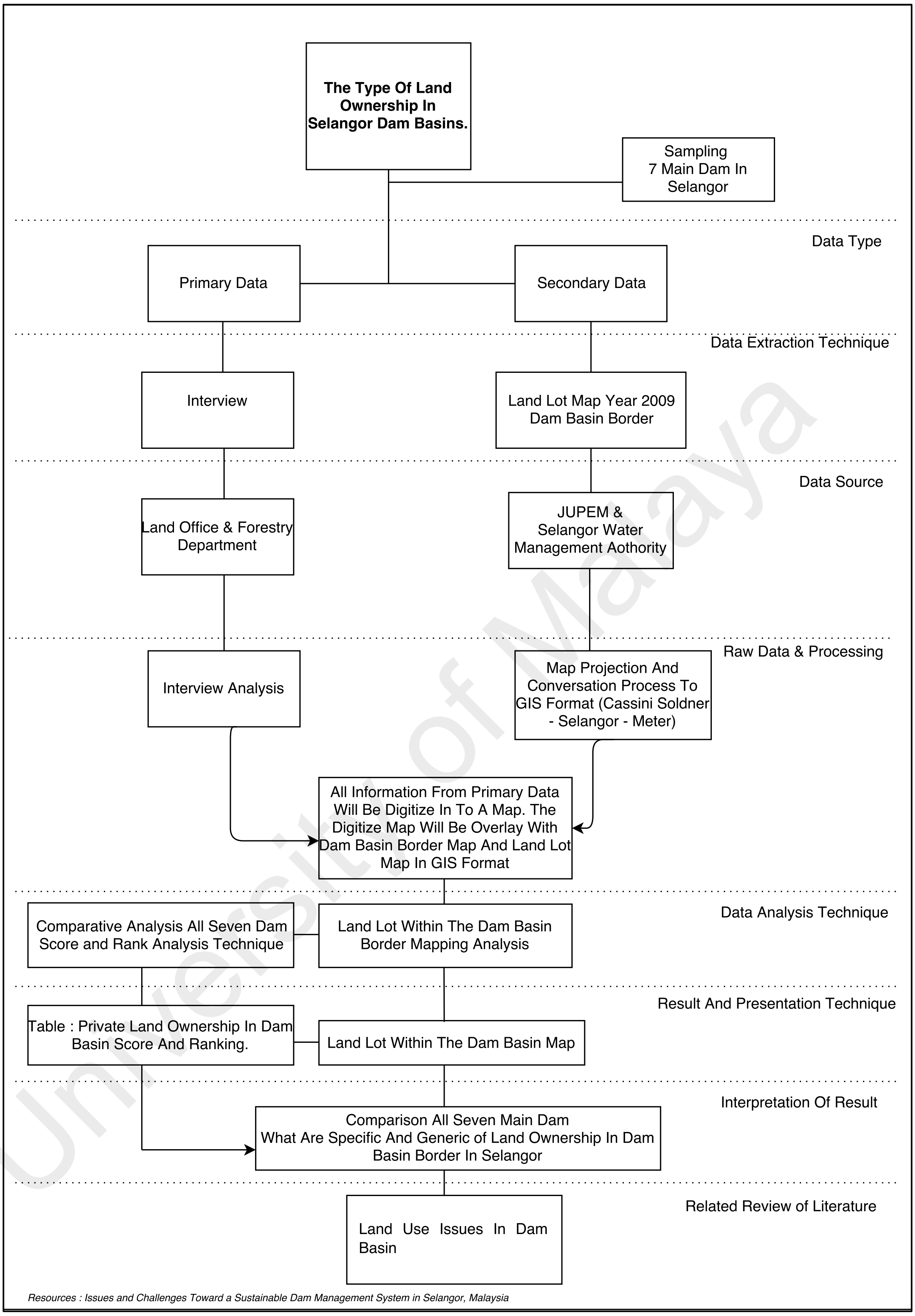


Figure 3.6 : Data Acquisition Process - The Type Of Land Ownership In Selangor Dam Basins

3.4 The Effectiveness of The Existing Dam Management Systems In Selangor

3.4.1 The Generic and Specific Components of The Selangor Dam Management Systems

This research Technique are used two types of data sources. First is primary data from the interview session and secondary data from the official document and report on the dam management and administration from related agencies in dam management and development surrounding the dams. The related agencies as, Selangor State Water Management Authority, State Land Department, Drainage and Irrigation Department, Town and Country Planning Department, all local government are involved, and operator such as SYABAS, ABBAS, SPLASH, National Security Council and others are related about the cope of responsibilities and their power sources in Planning, Control, and enforcement. All the data are from the official report review such as act, guidelines, standard and others. All the information has been analyze with content analysis and has come out with mind mapping of the structure of dam administration and management system in Selangor see figure 3.7.

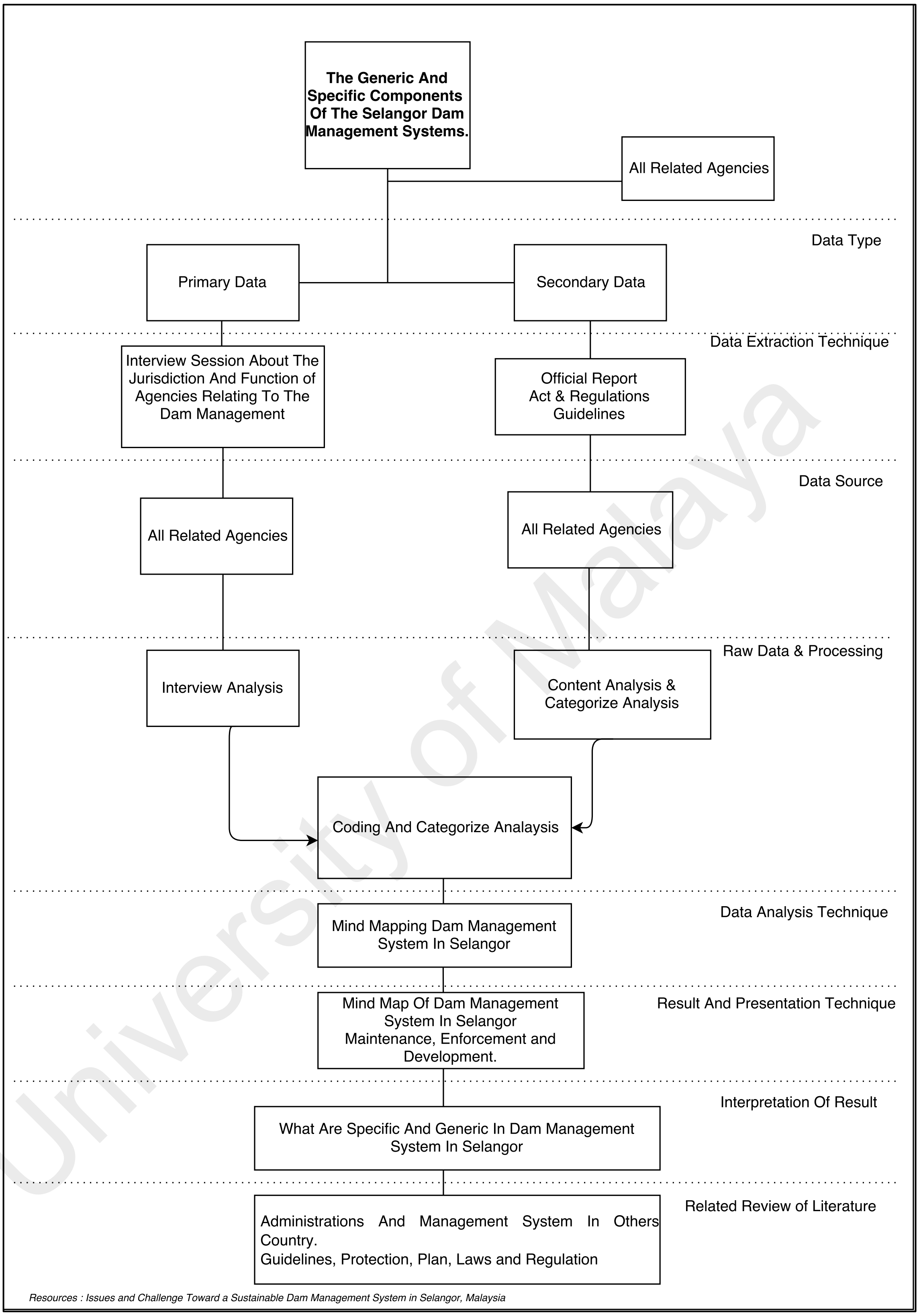


Figure 3.7 : Data Acquisition Process - The Generic and Specific Components of The Selangor Dam Management Systems

3.4.2 The Generic and Specific Of Issues And Challenges in Selangor Dam Management Systems

The technique will use is more on primary data collection. The interview session with officers from related agencies in dam management and development surrounding the dams. The related agencies as, Selangor State Water Management Board, State Land Department, Drainage and Irrigation Department, Town and Country Planning Department, all local government are involved, and operator such as SYABAS, ABBAS, SPLASH, National Security Council and others are related about the scope of responsibilities and their power sources in enforcement. And for better analysis all the issues are highlight from the interview session will be discus with all the data from the official report review such as act, guidelines, standard and others from the guidance from government officer to relate the existing act and regulation with their problem facing. Especially about the act and regulation conflict in land use control at the dam's water catchment area sees Figure 3.8.

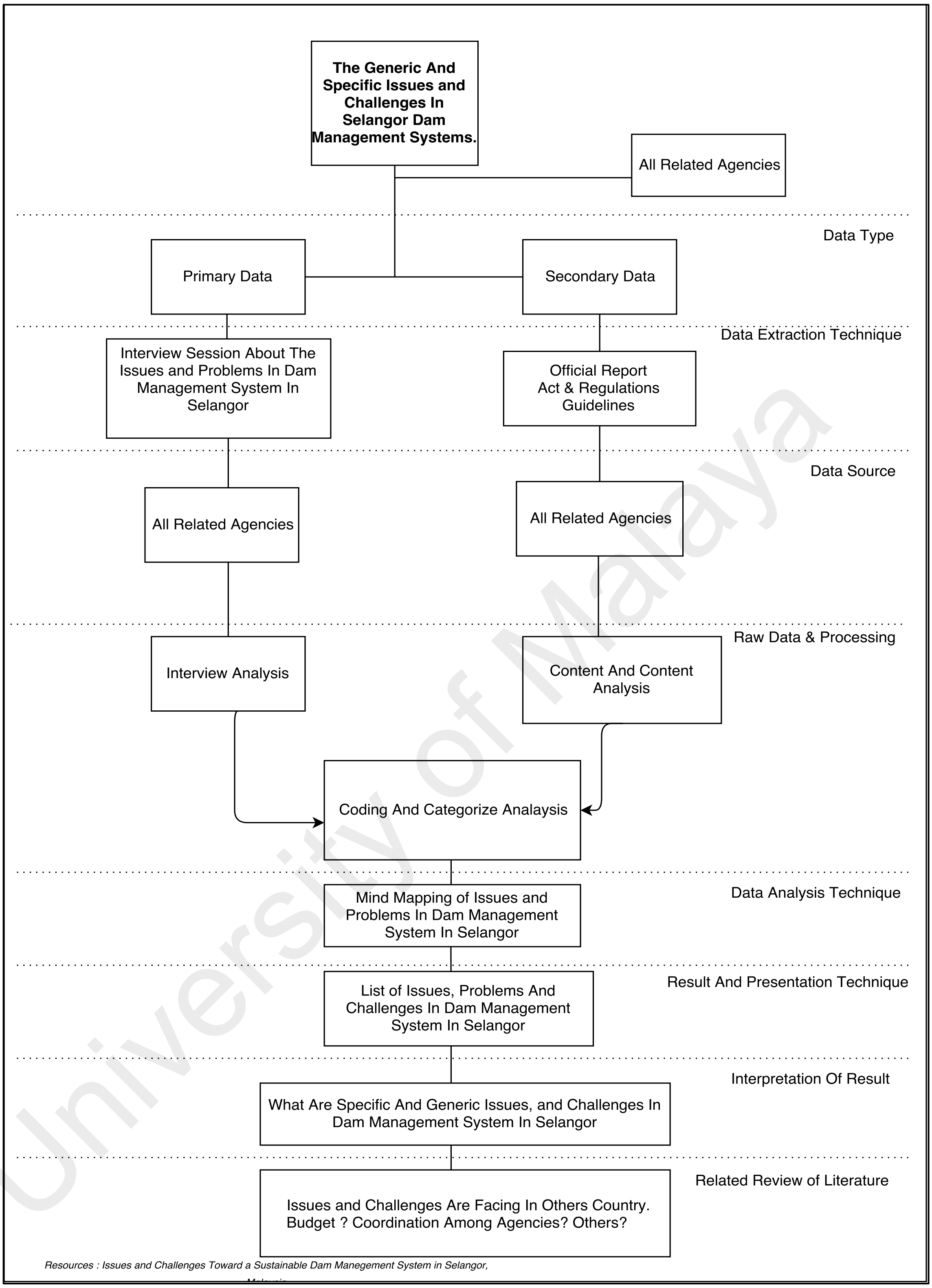


Figure 3.8 : Data Acquisition Process - The Generic and Specific Issues and Challenges In Selangor Dam Management Systems

3.4.3 The Selangor Dam Management Effectiveness Tracking Tool

To know the effectiveness of dam management system in Selangor, the management effectiveness evaluation tracking tool will be created specially for the dam management, see figure 3.9. This tool will be named as Selangor Dam Management Effectiveness Tracking Tool (SDMETT). By taking the example of Management Effectiveness Tracking Tool (METT) version 2007 provided by the World Bank / WWF Alliance for a special area. The indicator of the tool is provided a base on the Management Effectiveness Evaluation for Protected Area Framework by The World Conservation Union (IUCN). However, not all questions in METT of WWF Alliance, meet or correspond with dam management, because it is specially designed for specific specialty areas. In this regard, to make sure that it is appropriate and answered questions of this study. Some set of questions amended accordingly. The scope of the questions is also deference with METT by WWF Allience. Where the scope of this study is the management of the dam for the whole State of Selangor, it's included all the agencies involved in managing and administering the seven major dams. Instead, METT by WWF Allience just focus on one agency are in charge of unique special area for preservation. In the main assessment form (SDMETT), 41 questions are asked each with a four-point scale (0, 1, 2, and 3). The intention is the case that the scale to choose whether the situation is acceptable or not. Generally 0 is equivalent to no or negligible progress; 1 is some progress; 2 is quite good but has room for improvement; 3 is approaching an optimum situation. A series of four alternative answers are provided against each question to help assessors to make judgments as to the level of the score given. The scores are totaled and the percentage of the possible score calculated. It is noted that 'the whole concept of "scoring" progress is however fraught with difficulties and possibilities for distortion. The current system assumes, for example, that all the questions cover issues of equal weight. Whereas this is not necessarily the case. Scores will therefore provide a better assessment of effectiveness if calculated as a percentage for each of the six elements of the IUCN-WCPA Framework (IUCN 2007). Generally 0 - 33 is poor management; 34- 66 is Sound Manage and 67- 100 are Well Manage of land use conflict.As an added value, 4 special columns for SWOC added in the form of analysis. To fill the relevant answer related to the advantages, weaknesses, opportunities and constrain. This column will help in data collection to answer the last research question (The appropriate sustainable dam management for Selangor). The example of a question in SDMETT forms as on the table 3.2. Full set of questions will be addressed in chapter 5 - Result and Interpretation. Data acquisition and extraction to answer all questions in SDMETT form are involved two types, of data. First is primary data from interview session will be all related agencies in existing administration and management of the dam and the area in State of Selangor. Second data is from the official report, Act and regulation, and document related to the dam management system in State of Selangor.

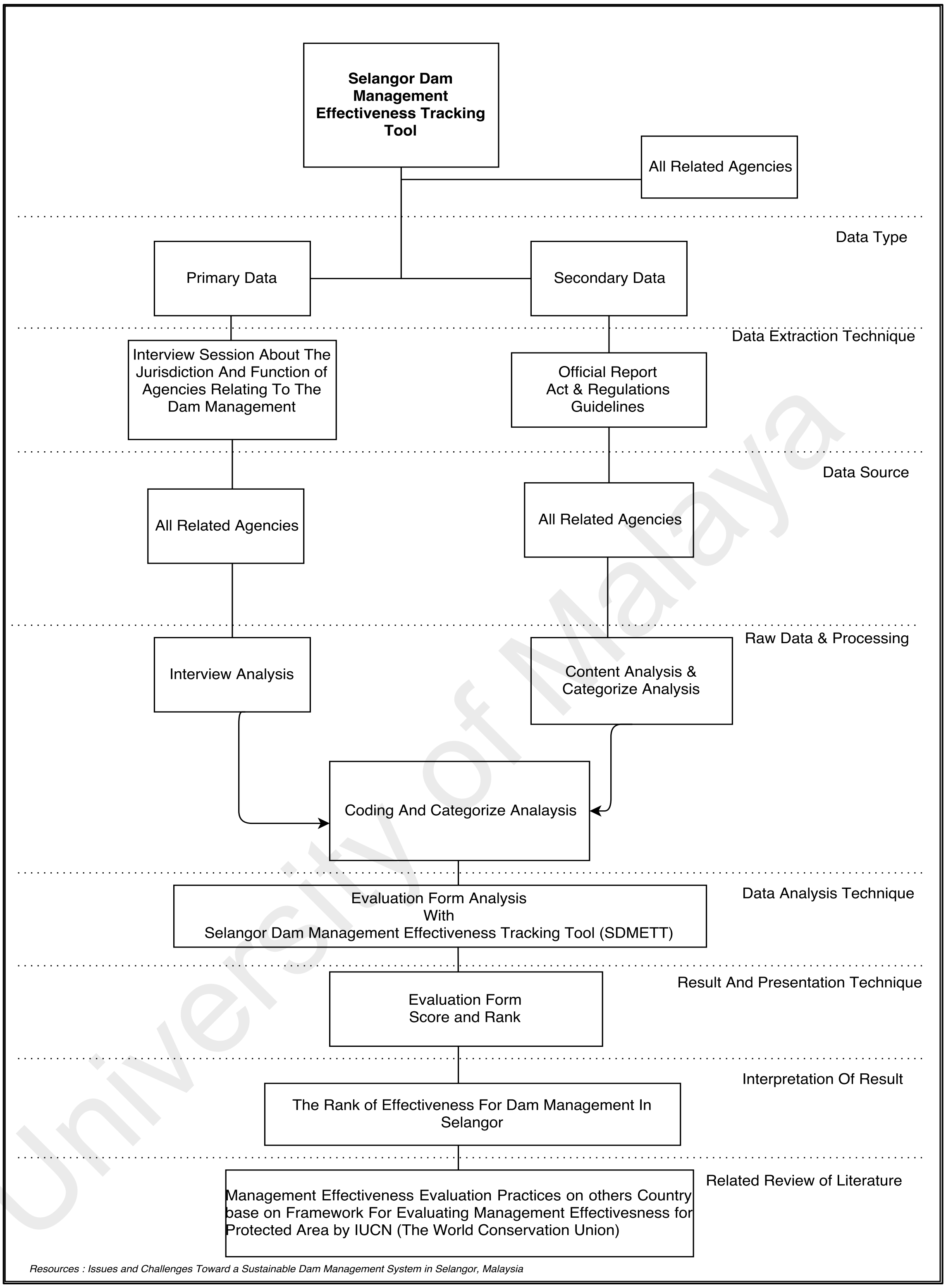


Figure 3.9 : Data Acquisition Process - The Selangor Dam Management Effectiveness Tracking Tool

Table 3.1: Example Question in Dam Management Effectiveness Evaluation Tool Form

Issues	Criteria	Score		Comment			
				S	W	O	C
Context							
1. Threats from human settlements or other non-agricultural land uses with a substantial footprint	Commercial and industrial areas	0					
	Housing and settlement	1					
	Tourism and recreation infrastructure	2					
	Not Significant	3					
	Not Significant	3					

3.5 The Sustainable Dam Management System Model For Selangor

3.5.1 Toward a Sustainable Dam Management Systems In Selangor.

To get the appropriate sustainable dam management system for Selangor, the technique is used as, qualitative technique. The data will absorb from the SWOC column in Selangor Dam Management Effectiveness Tracking Tool (SDMETT) from which, in research question eight (The effectiveness of dam management system in Selangor) see Figure 3.10. Data analysis method and technique is SWOC analysis technique. SWOC analysis is consistent with SWOT analysis. The deference. Is the word of threat are replaced to constrain. SWOT analysis is just an established method for assisting the formulation of strategy, Dyson, R. G. (2004).

SWOC analysis is same with SWOT analysis but in the dam management context, this study is more look on to constrain as the replacement to the threats. Because this study is more relate to the human, capital, infrastructural, and financial. There are limitations, meaning that an effective Dam Management System are limited or constrain by these shortcomings. SWOC analysis is to determine the strengths, weaknesses, opportunities, and constrain in Selangor Dam Management Systems. This analysis is involved in the collection of information about the internal and external factors, which have an impact on the management system. SWOC analysis is involved two steps of analysis, 1st is listing and identify strengths, weaknesses, opportunities, and constrain, 2nd is prioritize them.

3.5.1.1 Prioritization For Strengths And Weaknesses.

Strengths and weaknesses evaluated in 3 categories:

(a) ***Important.***

Important shows how important of strengths or weaknesses in the dam management system, as some might be more important than others. A number from 0.01 (not important) to 1.0 (very important) should be assigned to each strength and weaknesses. The sum of all weight should equal 1.0 (including strengths and weaknesses).

(b) ***Rating.***

A score from 1 to 3 is given to each factor to indicate whether it is major (3) or Minor (1).

(c) ***Score.***

Score is a result of important multiplied by rating. The highest score is a main focus on management system.

3.5.1.2 Prioritization For Opportunities, And Constrain.

(a) ***Important.***

Importance shows what extent the external factor might impact the dam management system. A number from 0.01 (no impact) to 1.0 (very high impact) should be assigned to each item. The sum of all weight should equal 1.0 (including opportunities and constrain).

(b) ***Probability.***

Probability of occurrence is showing how likely the opportunity or constraint will have an impact on dam management system. It should be rated from 1 (low probability) to 3 (high probability).

(c) ***Score.***

Important multiplied probability will give a score to prioritize opportunities and constrain. The highest score will be the main attention in dam management system.

At the end of the analysis to the appropriate sustainable dam management system in Stat of Selangor is listed and compared with the sustainable dam management system policy by World Commission On Dam. Detail analysis will be discussed in chapter 5 – Result and Interpretation.

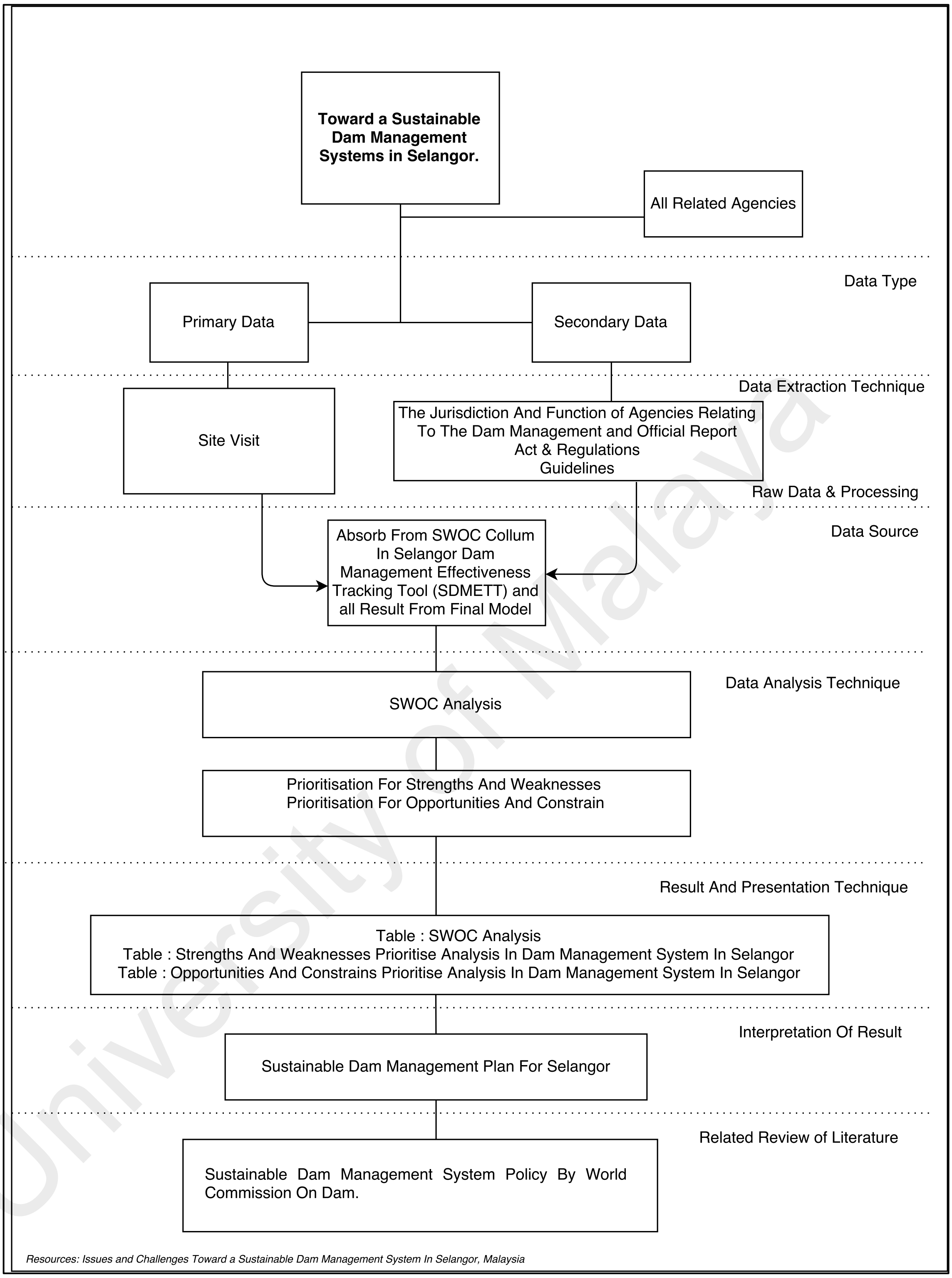


Figure 3.10 : Data Acquisition Process - Toward a Sustainable Dam Management Systems For Selangor

3.6 Sampling Technique

Sampling technique is a useful tool to help this research to identify the group, location or respondent. For some researcher their sampling frame maybe wide so the sampling technique will help the researcher to choose the right respondent. In this research on sampling is being use is all sample in the sample frame. Sample take part in this research has two categories of sample. Fist dam and location and additional agencies are involved in dam management system. Initial sampling technique is exhaustive sampling. Exhaustive sampling is contained an exhaustive inventory of members of the population, (Martella, Nelson, Morgan, & Marchand-Martella, 2013). Which mean all sample from a sample frame are chosen as a sample. The dam are choose as a sample is all main dam in Selangor, 1) Klang Gate Dam, 2) Batu Dam, 3) Langat Dam, 4) Semenyih dam, 5) Tasek Subang dam, 6) Sungai Selangor Dam, and 7) Sungai Tinggi Dam.

The same sampling technique is also being used to choose the related agencies are involved in dam management system in Selangor. Where all the related agencies are chosen as a sample in this research.

3.7 Structured Questions Interview Technique

The type of interview technique is used in this research are a personal interview technique and structured interview. Personal interviews method requires a person known as the interviewer asking questions generally in a face-to-face contact with the other person or persons, were at the times the interviewee may also ask a certain question and the interviewer respond to these, (Kothari, 2004). Kothari also mentions, the method of collecting information through personal interviews, is usually carried out in a structured way, where the interviews as a structured interviews are involved the use of a set of predetermined questions and of highly standardized technique of recording, the interviewer in a structured interview follow a grid procedure laid down, asking questions in a form and ordered prescribed, (Kothari, 2004). In this research, the structured interview will be involved the set of predetermined interview questions a shown at Selangor Dam Management Effectiveness Tracking Tool (SDMETT)

3.8 Conclusion

All of research technic are used in this research is a qualitative and quantitative method that involved the field study, report and document review, map review and interview session. Analysis technics are used in this research is mapping and spatial analysis technic, observation analysis, content and context technic, comparative analysis, Selangor Dam Management Effectiveness Tracking Tool (SDMETT) and lastly a SWOC analysis technic are used to answer the research question, objective and last to help this research to archive the research aims.

CHAPTER 4: THE REGION - RIVER BASINS AND DAMS IN SELANGOR

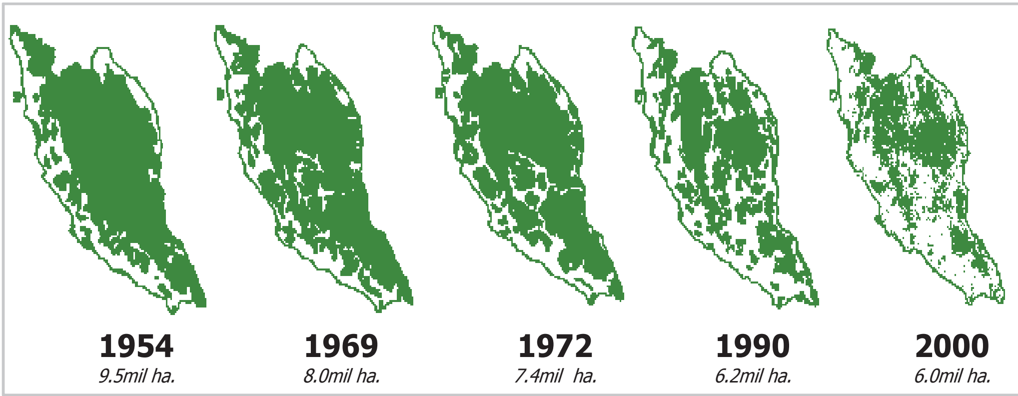
4.1 Introduction

This chapter discusses the two main topics. First, about the study region, which explain where the study region is located and why this study region has been chosen as a study area. Study region will cover the general scenario of Malaysia and the development issues in State of Selangor and why Selangor State is chosen in dam management topic of research. Second discussion will go detail on the river basin and dam catchment characteristic, geological and topographical features, land use, hydrology and meteorology.

4.2 The Region

4.2.1 Malaysia – Physical Setting

Malaysia is located at 3° 8′ 0″ N, 101° 42′ 0″ E, with a land area of 329,847 km2 (127,355 sq. mi). It has land borders with Thailand in West Malaysia, and Indonesia and Brunei in East Malaysia. And it is related to Singapore by a narrow causeway and a bridge. The two parts of Malaysia, separated from each other by the South China Sea, share a largely similar landscape in that both Peninsular and East Malaysia features coastal plains rising to hills and mountains. Study area in this research is at Selangor State Peninsular Malaysia. That means next discussion about the study area will cover is on the west Malaysia. According to the National Physical Plan 2, Peninsular Malaysia has suffered a substantial loss in forested areas and wetlands including forest fragmentation. Only 45% of the total land area in Peninsular was forested in 2008. To date, the Peninsular has lost a substantial area of forest cover from 9.5 million hectare (1954) to 6 million hectare (2000) but somewhat stabile to about 5.9 million hectare (2008) which is an indication of a positive trend (see Figure 4.1).



Source : 1954, 1969 & 1972 – Jomo et al. (2004) after Aitken et al. (1982: 161).
1990 – Jomo et al. (2004) after Anon (1992), 2000 – Stibig et al. (2002: 11).

Figure 4.1: Reduction of forest area peninsula

Malaysian peninsula forest reduction will give an impact to the continuity of the water supply source. Particularly is a dam area, which is usually situated in the forest area. When urban area began to spread to forests area and water resources such as the dam began to receive threats from development. Towards ensuring this phenomenon is controlled and help maintain water supply in the country. 2nd National Physical Plan has set under NPP 26 (National Physical Policy 26) All surface and ground water resources shall be safeguarded and managed sustainable. Under IP 19: Water Catchment Areas and IP 20: Ground Water Resources, measures have listed (1): Catchment areas of existing and proposed dams shall be gazette as water catchments to avoid further encroachment of incompatible land uses into such areas. (2): Structure and Local Plans shall identify and delineate water intake catchments and ground water recharge zones as ESA (Environmental Sensitive Area) Rank 3 areas requiring special land use management. The type and intensity of development shall be strictly controlled being dependent on the nature of the constraints. And (3): All having and future land use activities within water intake catchments and recharge zones should not jeopardies nor add to the cost of water treatment for human consumption. New industrial development and other activities that could be a source of water borne pollution shall not be permitted whilst existing industries shall be required to adopt appropriate environmental management measures to safeguard public health and water quality. Though the policy has been set in watersheds and dams should be kept well lit as environmentally sensitive areas and prohibition of development. There continue to be many issues of land use controls to be obstacles to the implementation of this policy as discrepancies in the implementation of various laws related to land use control area around the dam. Which will discuss further in this study.

4.2.2 Selangor - Physical Setting

Selangor State is located in the center of Peninsular Malaysia's west coast and around the Federal Territory of Kuala Lumpur and Putrajaya. Selangor also bordered by Perak to the north, Pahang to the east, Negeri Sembilan to the south and the Strait of Malacca to the west. Selangor generally has sloping terrain and is located between the range of hills and the Strait of Malacca. Selangor state covers an area of 796.084 hectares (8,000 square kilometers). Selangor in geographical position are rich with natural resources. That's make Selangor as one of the states forward in terms of economic development in Malaysia. Selangor is also the area of land included in the National Growths Conurbation. Where, National Growth Conurbation is a Kuala Lumpur Conurbation, which encompasses Kuala Lumpur, Putrajaya, Shah Alam, Klang, Nilai and Seremban, is proposed as the National Growth Conurbation. Effectively, Kuala Lumpur Conurbation stretches from Kuala Selangor in the north to Port Dickson in the south. The Kuala Lumpur Conurbation is to provide for a potential population of 10.37 million or 37% of the Peninsular Malaysia population by the year 2020. The reason why Selangor State is chosen as the study area for this research is Selangor State is the fastest growing state in Malaysia. Selangor State which has shown an increase in built-up areas closer to the dam. Built-up land use in 1991 represented an increase of 100,234.12 hectares in 2002 with an average annual growth rate of 11.8%. Built-up land use for the year 2002 of 141,745.46 hectares and in 2009 represented an increase of

168,634.35 hectares of 21.19%. The most significant increase in the Petaling District. Built-up land use consists of residential land use, industry and business. Other land use is institutional, open space and recreation, transportation and utilities and infrastructure. In general, the Selangor State experienced rapid development since the early 1990s. Development of growth centers and new towns have been opened for the purpose of urban development due to population growth occurred in the State of Selangor. In each component of the proposed land use change due to land use would occur increase of built-up land use. Built-up land use for 2009 increased by 15.6% over 2002 built-up land use and agricultural land use in 2009 decreased by 10% opposed to 2002. Forestland use also decreased by 5% from 2002. In 2012 Built-Up areas continue to rise to 209,534.58 hectares. See Figure 4.2

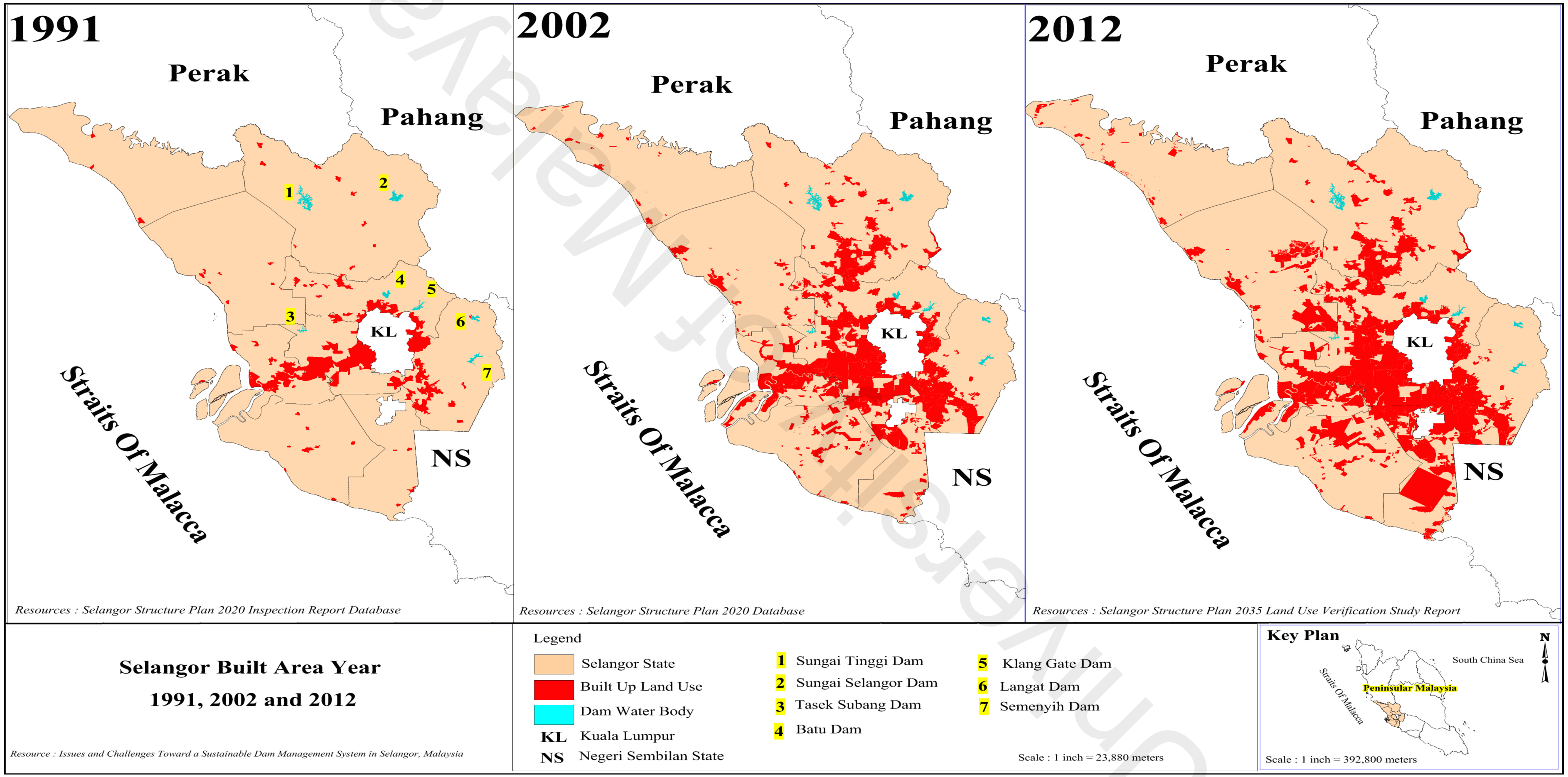


Figure 4.2 : Selangor Built Up Area Year 1991,2002 And 2012

Selangor state facing the crisis in water resources management. According to projections, from the SYABAS water needs, shows the existing water resources are not sufficient to meet future needs. Average water demand for an extended period is subject to daily changes, which are subject to various factors such as the weather. Between April 1 to May 15, 2011, during the hot weather. Demand that the recorded supply has increased to excessive levels, which see 4200 million liters per day (Table 4.1).

Table 4.1: Water Production Capacity Against Average Water Demand from April 1 to May 15, 2011

Date	Daily Water Supply (MLD)	Water Production Capacity (MLD)	Reserve Capacity (MLD)	Margin Reserve (%)
09 May	4188	4326	138	3.19
10 May	4166	4326	160	3.70
11 May	4242	4326	84	1.94
12 May	4154	4326	172	3.98
13 May	4223	4326	107	2.38
14 May	4190	4326	136	3.14
15 May	4193	4326	133	3.07
16 May	4201	4326	125	2.89

Regarding to SYABAS, demand growth rate results in an increase, in metered consumption. Portion of increase in metered consumption due to improvement in reduction in the commercial component of NRW is 104.5 MLD. And the portion of the increase in metered consumption due to natural growth is 403.5 MLD. Average natural demand growth rate over five years is 3.5% per year to see (Table 4.2).

Table 4.2: Water Demand Growth Rate In Selangor

At Beginning Of Year	Water Demand (MLD)	Metered Consumption (MLD)
2005	3,766	2,155
2006	3,807	2,354
2007	3,778	2,450
2008	3,794	2,515
2009	3,813	2,573
2010	4,015	2,663
Increase Over 5	249	508

SYABAS also stressed the need for reserve capacity. Where reserve capacity is required to be included in the planning demand to cater for peak demand variation such as seasonal variation, where during the dry season and the festive season, in Selangor, records shows that it can reach up to 7% of average demand. Reserve capacity is also needed to mitigate incomplete connectivity problems within the distribution systems. And also to cater for speedier recovery period after plat shutdowns of supply interruptions due to raw water pollution, electricity break down, breakdown of major equipment, scheduled maintenance and flood leading to WTP. The last important of capacity reserve is to cater for minor hydrological risk such as minor drought that reduces production from certain WTPs.

But the statement from the Selangor Water Management Authority is contradictory. Where they stressed that water resources in the seven major dams still enough for future needs. According to LUAS in Selangor Kini 30 September to 7 October 2011, (Selangor State Official Newspaper), They pointed out that, in all the status of the water level intakes, for the needs of water treatment plants in seven major dams and rivers in the Selangor State is good and not worrying. The average water level in the dam in 2011 is increased from the previous year see (Table 4.3).

Table 4.3: Water Storage Level Of The Dam On 20 September 2011

Dams	Storage Percent (%)
Sungai Selangor	78.34
Sungai Tinggi	85.78
Batu	100
Klang Gate	100
Tasik Subang	95.64
Sungai Langat	100
Sungai	100

SWMA refuse the claim that water reserves are shrinking by the SYABAS. They also pointed out that. SYABAS is responsible for ensuring that the water reserves in the 10 percent. But what happens, water reserves are at levels 3 to 5 percent only because the plant is not in a position to increase production. According to the State Government, the issue of water crisis deliberately raised by SYABAS and consumer associations as the refusal of the state government to approve the water treatment plant project Sungai Langat 2. Construction of the plant can be implemented if water restructuring of water management can be completed and agreed upon all parties. Because the federal government does not want to hand over the management of water to the state government and the state government has also refused to approve the project Sungai Langat 2 treatment plant, then it becomes a difficult issue to resolve.

The latest, information, through the monitoring of dam capacity by Selangor Water Management Authority (SWMA), seven dams in Selangor are in good and satisfactory condition. Until December 8, 2012, the capacity of water for Tasek Subang Dam, Semenyih Dam, Dam Langat, Klang Gates Dam and Stone Dam is 100% full level. Overflow also occurs for Tasik Subang Dam, Semenyih Dam, Dam Langat and Klang Gates Dam. There is not any cooperation in water resources management in Selangor state between the federal government and state governments. And this conflict is contradicted with the sustainable dam management system. As well as the implementation of interstate water transfer issues. Where has no consensus from both parties in decision-making on water resource management? Consist with national physical plan. To overcome the invasion and reduction, forest and water resources, the state has set Selangor Water Bodies such as lakes, mines, reservoirs, and natural drainage area of 16,710.47 hectares should be preserved, protected and gazette.

4.3 River Basins And Dams In Selangor

River Basin and dam locality will identify the status and character of the dam in the river system in Selangor. Where there have eight river basins in Selangor, but the three main river basin in Selangor is a Klang River Basin, Langat River Basin and Selangor River Basin. All dams located upstream the river, and are located on a different river. There have no dams in the state built-in terraces level. Sungai Tinggi Dam and Sungai Selangor Dam are located in the Selangor River Basin. Batu Dam and Klanga Gate Dam are located in the Klang River Basin. Langat Dam and Semenyih Dam are located in Langat River Basin. Only one Dam is located in Buloh River Basin is Tasek Subang Dam. Generically all dams in Selangor are located upstream in deference river. On average, every two dams in the state are located in the same river basin, except Subang Lake Dam is a dam only found in the river basin buloh. Selangor dams character is different from other places because of the suitability and the presence of suitable sites to build dams is limited. It is also dependent on the height factor. See (figure 4.3). Next discussion will follow the for river basin and the dam basin.

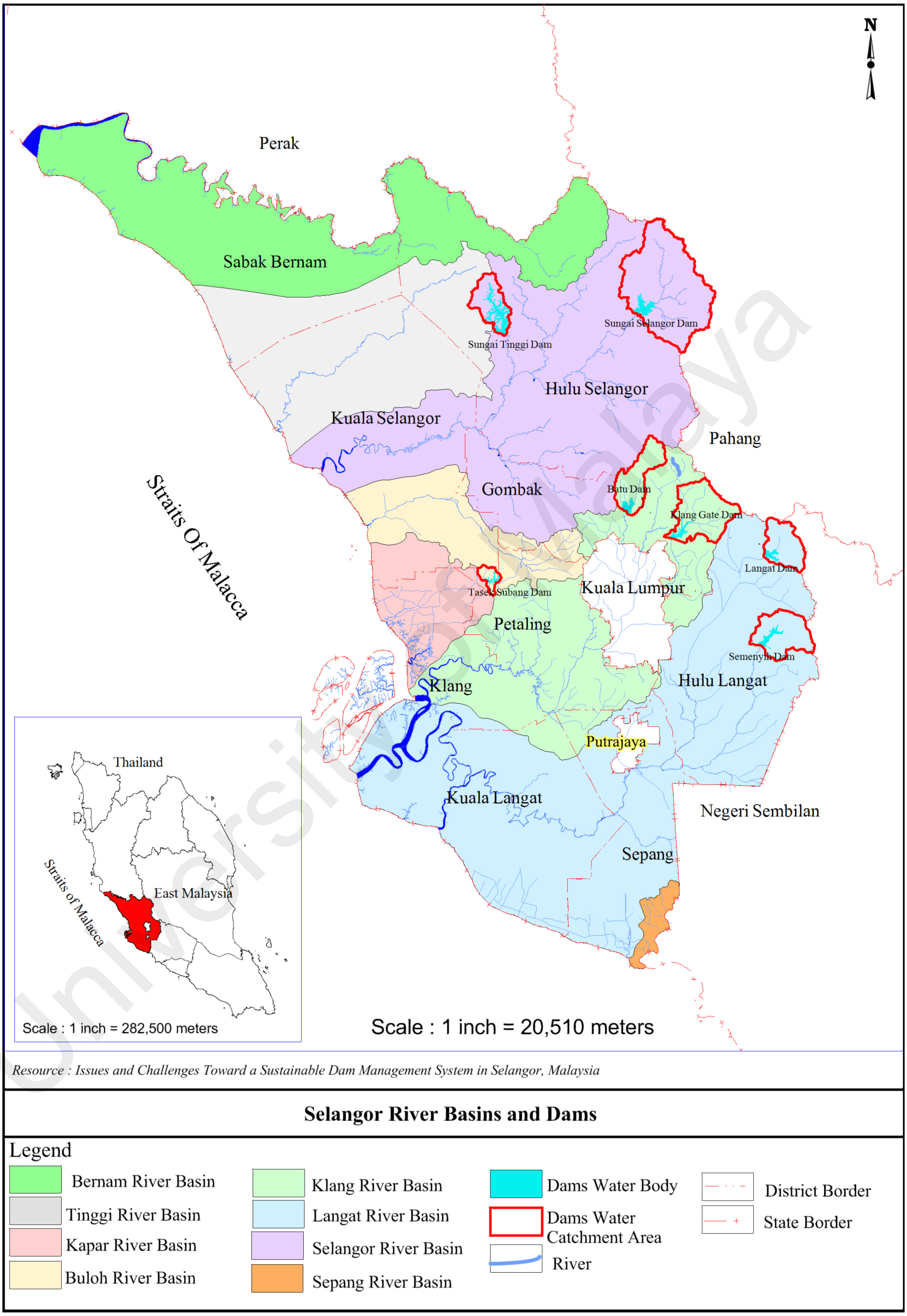


Figure 4.3: Selangor River Basins And Dams

4.3.1 Selangor River Basin – Sungai Selangor Dam and Sungai Tinggi Dam

4.3.1.1 Physical Characteristics And It's Location

The upper catchment of the Selangor River Basin are steep undeveloped. Have a 25 rivers in Selangor River Basin. Sungai Tinggi Dam Basin is located Sungai Buloh in Selangor River Basin and was located in Hulu Selangor District, Sungai Tinggi Dam (STD) is regulating dams located respectively at the riverheads of Sungai Selangor and Sungai Buloh, major tributaries of Sungai Selangor. This dam serves to control the quantity and water level of Sungai Buloh and Sungai Selangor that supply the water sources to the Rantau Panjang and Bukit Badong Water Treatment Plant.

Sungai Selangor Dam, is located at in Kuala Kubu Bharu, Hulu Selangor District, 5km east of Kuala Kubu Bharu at Km 66.5 of Kuala Kubu Bharu – Bukit Fraser Road. Sinai Selangor Dams is a control (regulating dam) that can accommodate a total water This dam contributes 60% of water supply in the Klang Valley. Tributary area for both dam is Klang valley, Kuala Selangor, Hulu Selangor sees figure 4.4.

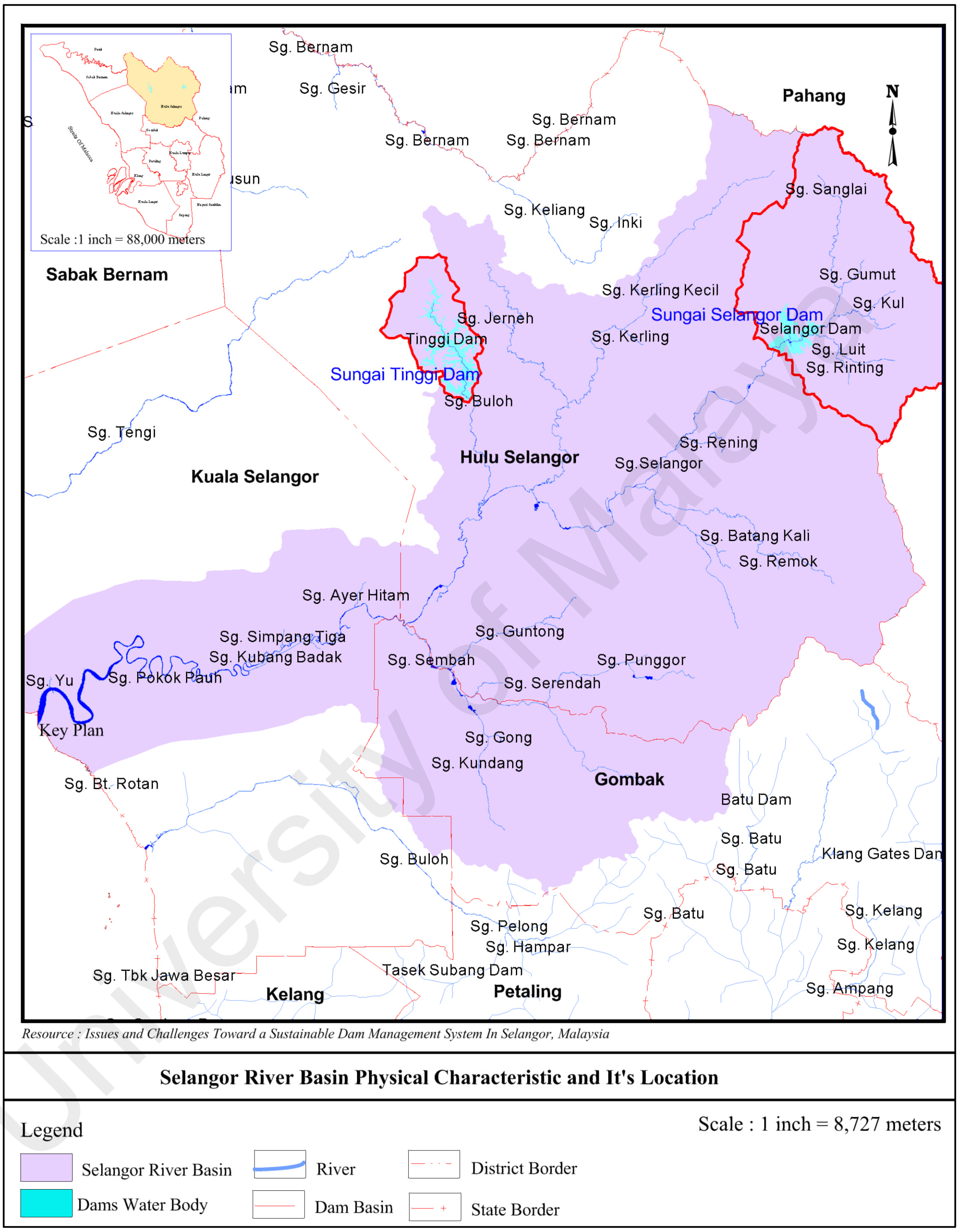


Figure 4.4: Selangor River Basin Physical Characteristic And It's Location

4.3.1.2 Topographical Features

(a) Selangor River Basin Relief

Selangor Dams Relief is to identify the height, and location of the high ground around the dam area in Selangor. Where, Figure 4.5 shown, Sungai Tinggi Dam highland categories are on average 60 meters to 300 meter high, while Sungai Selangor dam area is 60 meter to 600 meter. All high ground is located in the upper catchment where are the two dams are located. The most, high catchment reaches the Sungai Selangor Basin Area. At the middle catchment, the level only covers around 60 meter below. And at the lower catchment is below 60 meters.

(b) Selangor River Basin Slope Level

The upper catchment, are high location with slope level 25 degrees above and hit the area where the Sungai Selangor Dam is located. At the middle catchment of the almost all area is covered by slope level below 12 degrees. There are several area at Gombak district sees figure 4.6.

(c) Selangor River Basin Geology

Much of the upper catchment of Selangor River Basin is underlain with granitic rock with small isolated areas of Silurian meta-sediments (phyllite, shist and state limestone. Part of the mid-section of the basin occupied by devonian (limestone and sandstone are locally prominent). Quaternary (marine and continental deposits: clay, silt, sand, peat with minor gravel) on the coastal plains and riverine areas account for 55% of the total area of catchment for paddy cultivation and palm oil plantations see Figure 4.7.

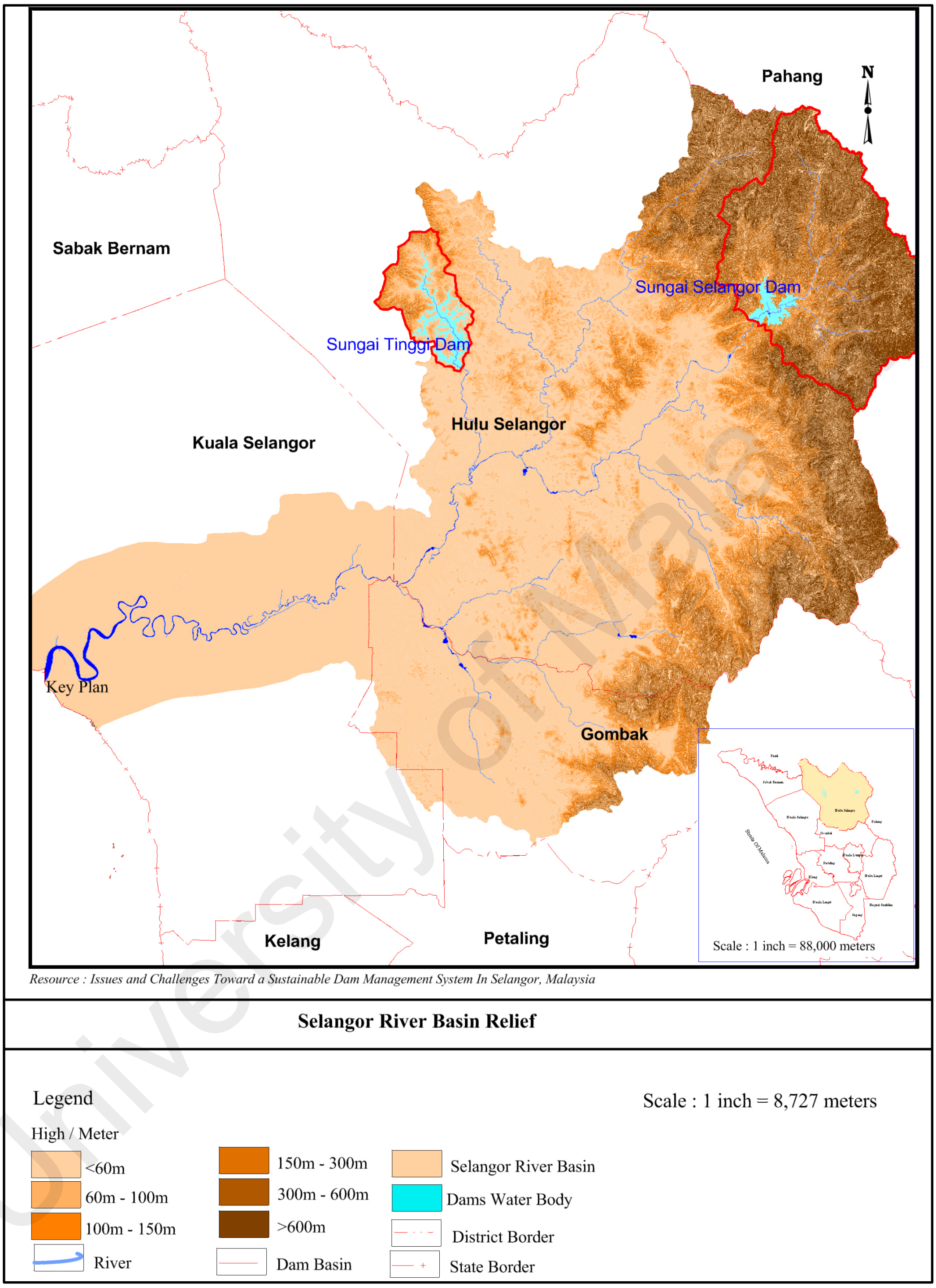


Figure 4.5: Selangor River Basin Relief

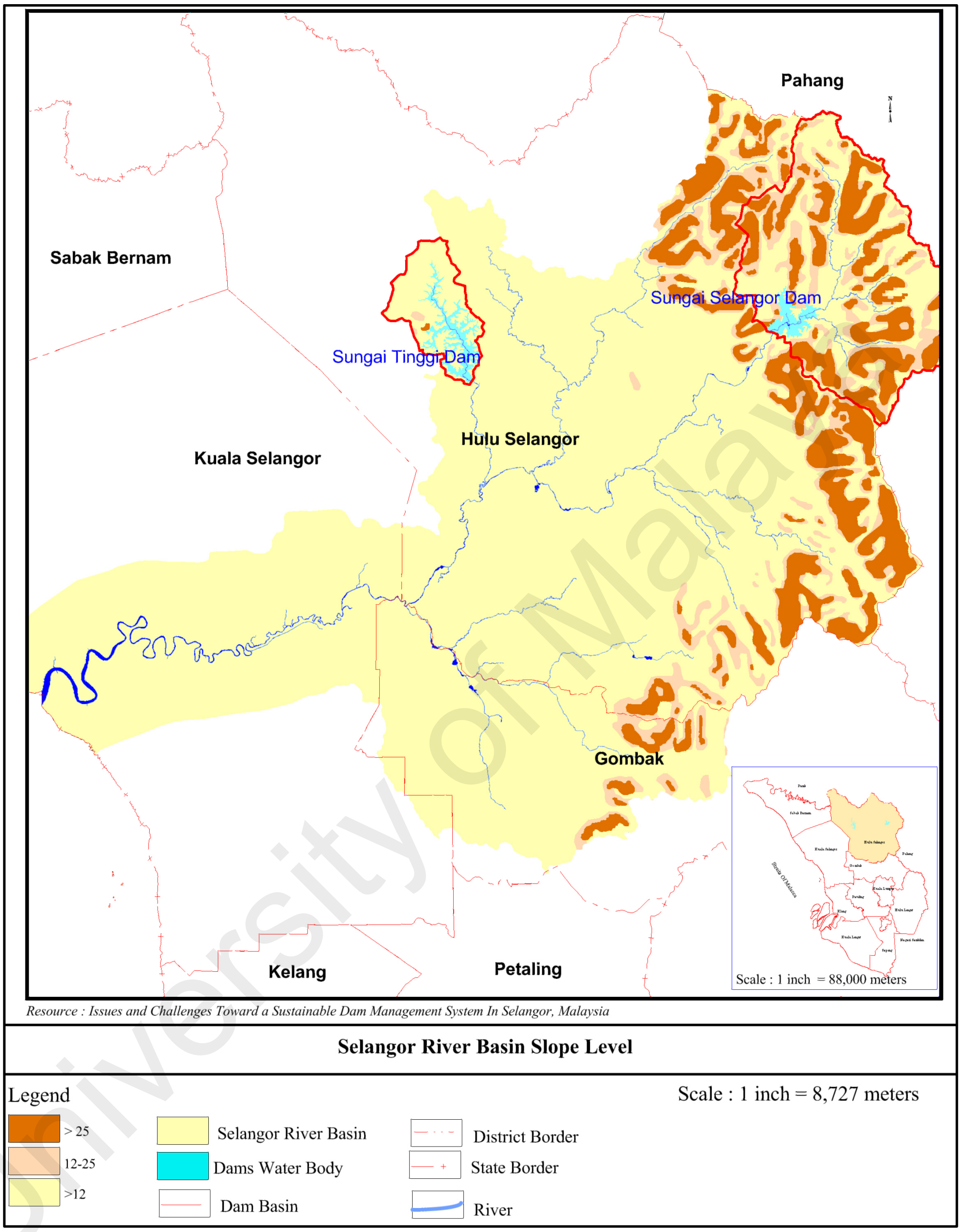


Figure 4.6: Selangor River Basin Slope Level

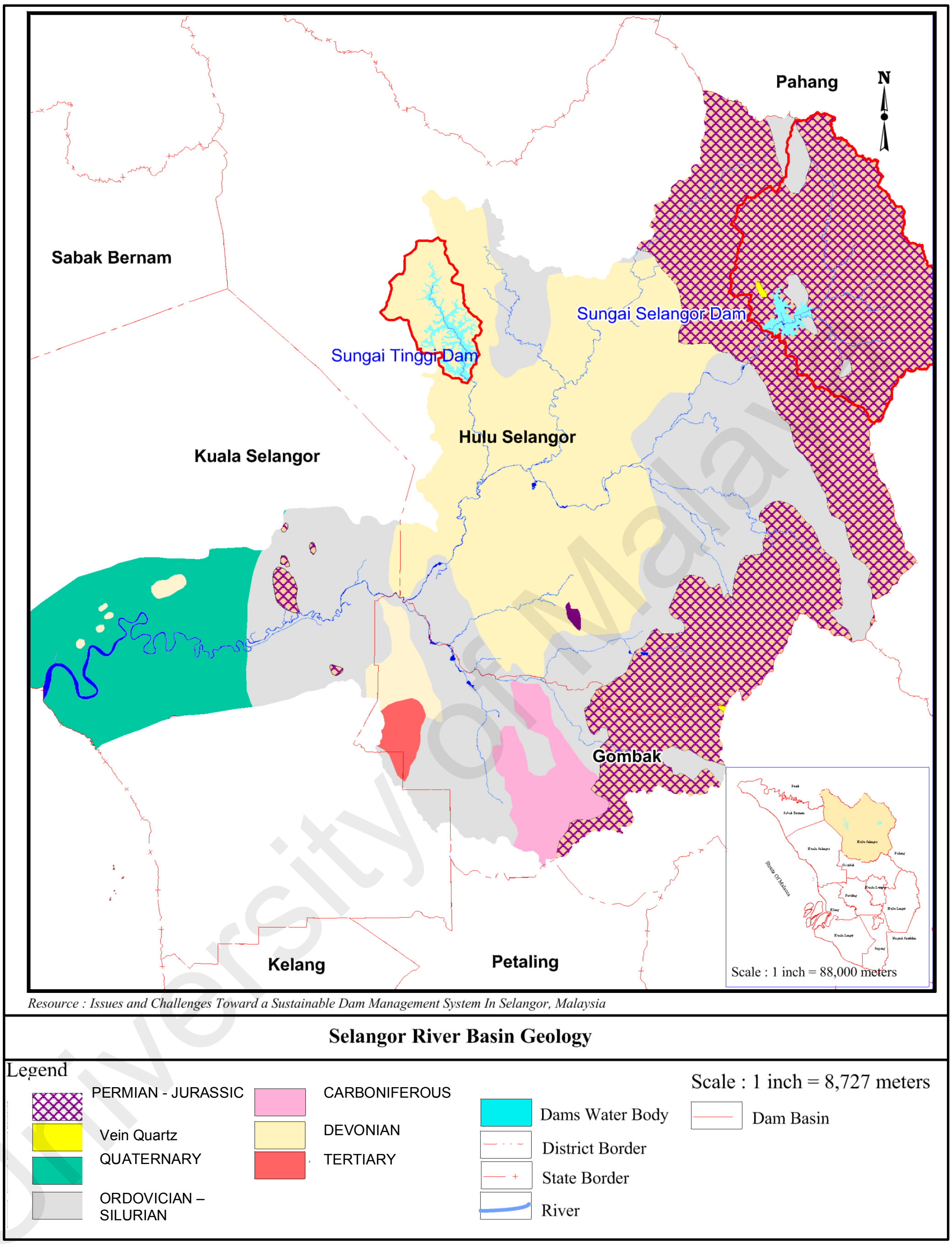


Figure 4.7: Selangor River Basin Geology

4.3.1.3 Land Use

Selangor River Basin is covered by multi land use of the deferent level of catchment area. Upper catchment area is fully covered by the forest land. There also have a federal road heading to the Bukit Fraser. This area also covered the Sungai Selangor Dam basin Area. The middle catchment Sungai Tinggi dam is located. Half of the area are covered by agricultural land use, and the Housing. There has a numerous industrial area. But in the Sungai tinggi dam Basin all covered by forest land use. There has been a highway near the Sungai Tinggi Dam Basin border. Meanwhile, the lower catchment covered by a huge agricultural land, several housing, institutional and industrial land sees Figure 4.8.

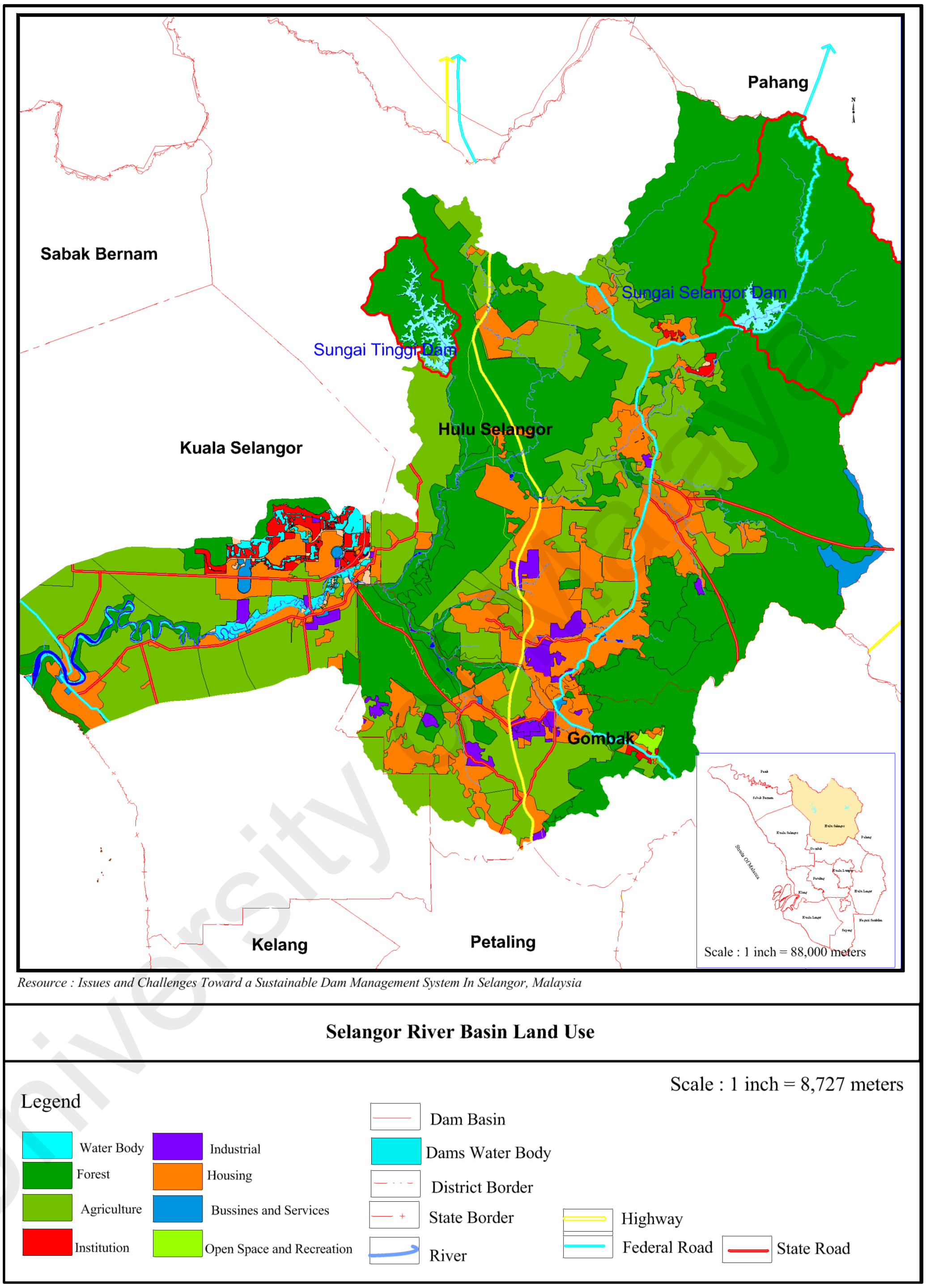


Figure 4.8: Selangor River Basin Land Use

4.3.1.4 Hydrology and Meteorology

(a) Selangor River Basin Surface Water Volume

Integrated surface water – ground water interaction model has reveals that the all three rivers in Selangor only receive water from groundwater and does not feed the groundwater. This may be due to the fact that due to the higher in ground elevation, The ground water table always remains higher than the surface water level (SWMA, 2014). The amount of aquifer contribution to the Selangor River Basin, calculation show at the Table 4.4.

Table 4.4: Year Wise Approximately Selangor River Basin Surface Water – Ground Water Interaction Volume (Mm^3)

Year	Surface Water – Ground Water Interaction Volume (Mm^3)
2008	109
2009	96
2010	96
2011	97
2012	99

(Resource : Selangor Water Management Authority. (2014). Selangor Groudwater Availability Study For SWMA Volume 1, Main Report, December 2014. Selangor.)

(b) Selangor River Basin Surface Water Quality

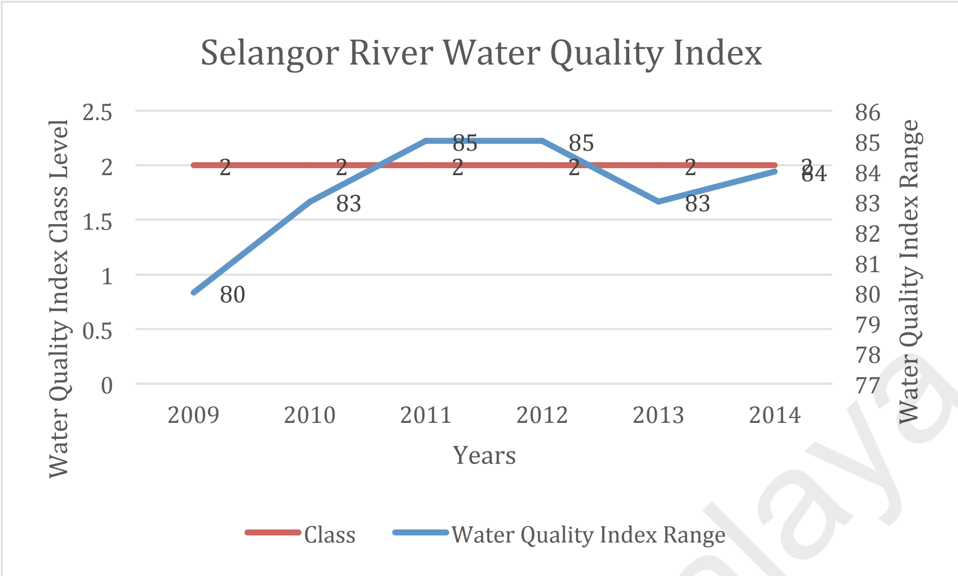
There are two standards used to assess the river's water quality and its uses. First is, Water Quality Index (WQI) by the Department of Environment (DOE) see Table 4.5 and Quality of Raw Water for drinking water purposes by the Ministry of Health Malaysia (MOH). However standards commonly used in the monitoring of raw water quality in river basins are the Water Quality Index by the Department of Environment.

Table 4.5: Water Quality Index (WQI) by the Department of Environment

Class	WQI Range (%)	Classification	Index Range (%)
I	92.8 – 100	Natural conservation of natural water sources and does not require any treatment.	Clean (81-100)
II	76.63 – 92.8	Clean, ideal for water supply but regular treatment is needed for that purpose	
IIB			
III	52.47 – 76.63	Clean status, suitable for water supply but further treatment is required for that purpose.	Partially Polluted (60 – 80)
IV	29.74 – 52.47	Irrigation purposes only.	Polluted (0 – 59)
V	<29.74	Nothing like the above	

Resource : Department of Environment

Figure 4.9 Shows the Selangor River Water Quality Index reported by department of environment from 2009 to 2014. Selangor River Water quality index class level from 2009 to 2014 is 2, which mean the water is clean and ideal for water supply but regular treatment is needed for that purpose. There is no change to the level. But there is an increase in water quality index range from 2009 to 2011. It's from Partially polluted to clean level. The clean level is maintain until year 2014 event the water quality index range is decreased in the year 2013 and increase in year 2014



Sources : Department of Environment

Figure 4.9: Selangor River Basin Surface Water Quality

(c) Selangor River Basin Ground Water Capacity

The ground water capacity at Selangor River Basin upper catchment is below 2500 gallons per hour / well and is covered by the high land area. Meanwhile mid-section occupied by groundwater between 2500 – 4000 gallon per hour / well and another half is below 2500 gallon per hour / well. Groundwater capacity at the lower catchment is 6000 gallons and below. See Figure 4.10.

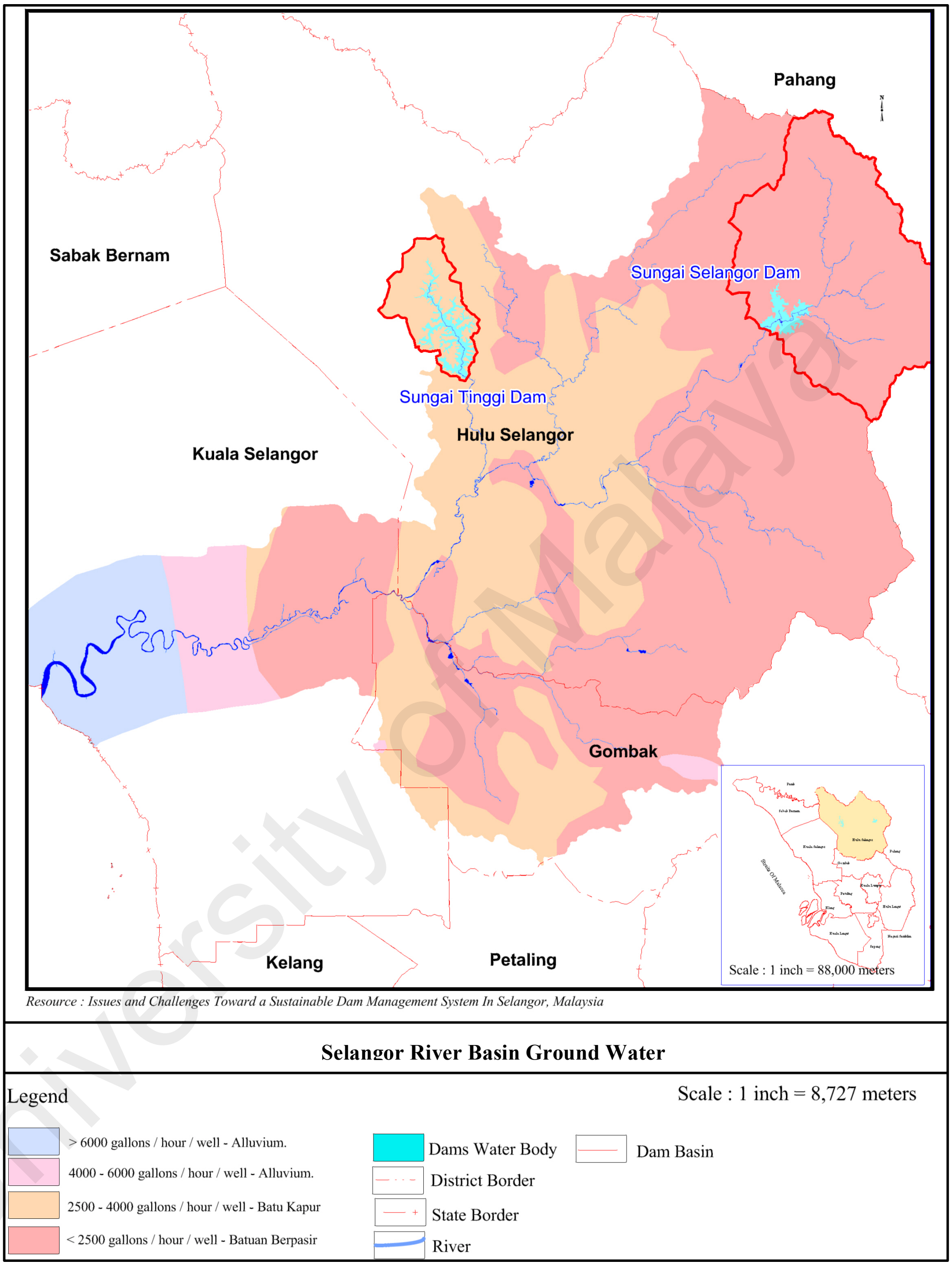
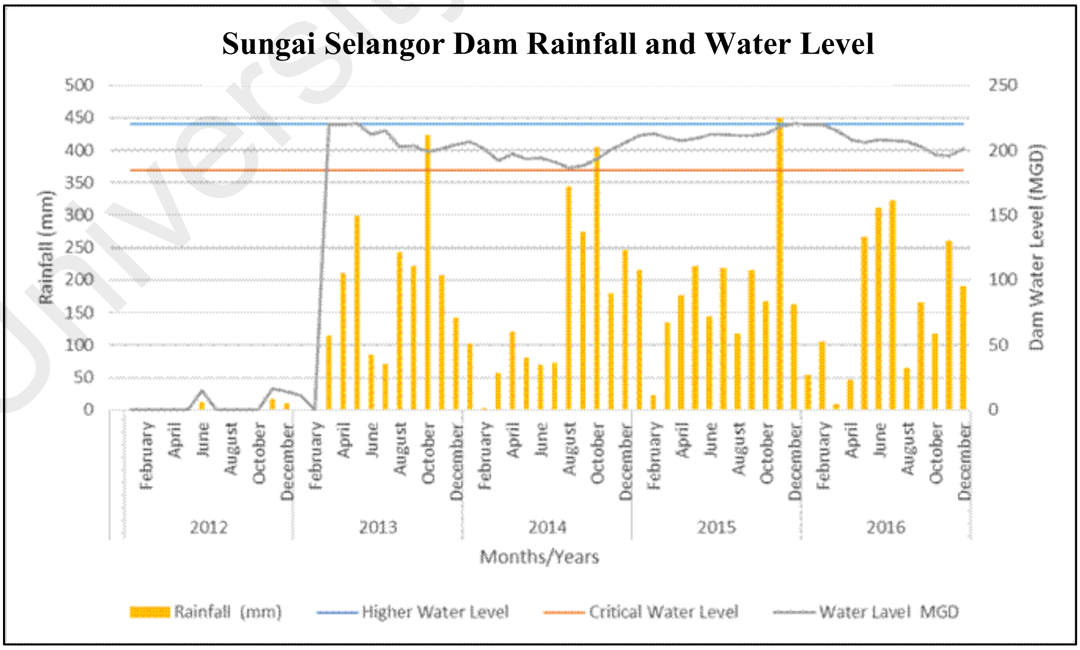


Figure 4.10: Selangor River Basin Ground Water

(d) Sungai Selangor Dam and Sungai Tinggi Dam Meteorology

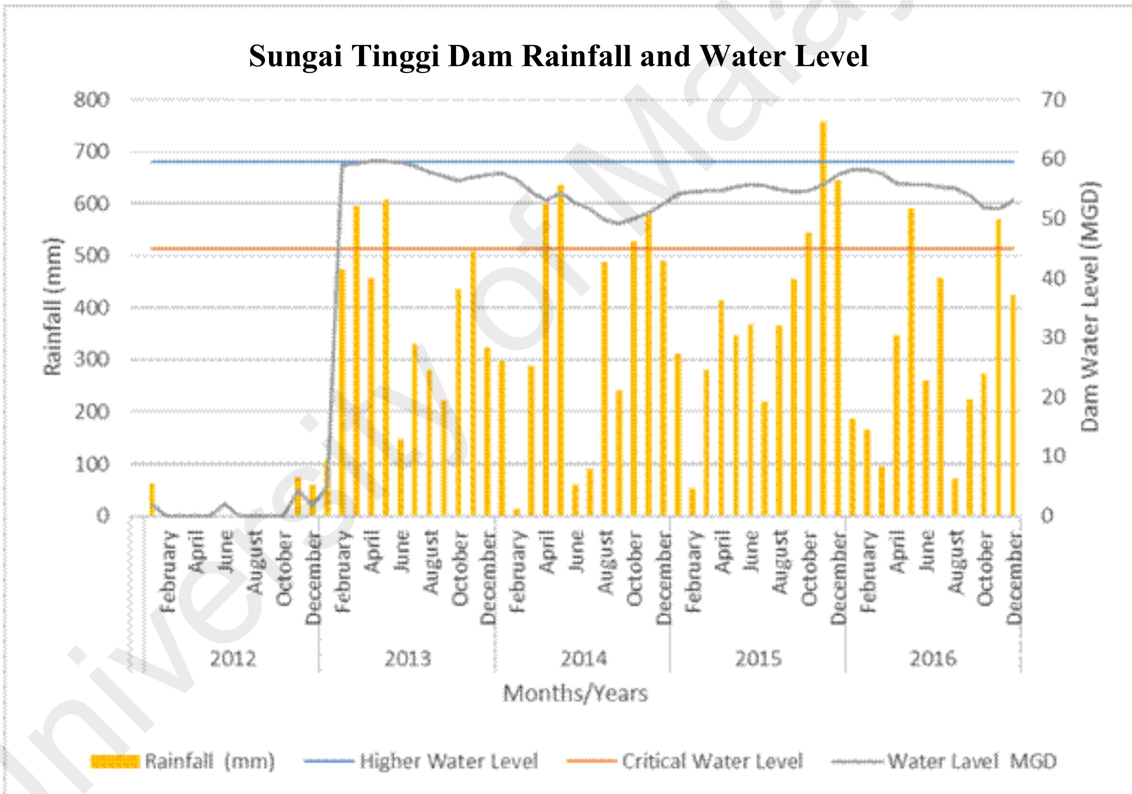
Figure 4.11 shows Sungai Selangor Dam has a significant difference compared to other dams in Selangor. When the northeastern monsoon is carrying rain, the Sungai Selangor Dam shows a decrease in rainfall rates in catchment areas between November to mac for 2013 to 2016. The highest rainfall rates for 2013 to 2015 in October occurred during the southwest monsoon transition to the northeast monsoon. The highest rainfall is in October from 2013 to 2015. The highest rainfall rate for 2016 is in June of 300 mm. This is quite contrary to the southwest monsoon properties that carry the dry season during the month of June. In total, the rainfall decreases during the southwest monsoon season for 2013 to 2016, between May to September. However the water level of the dam is still above the level. Except, the dam water level in August 2014 reached a critical level. Even though during the month rainfall is over 300 mm high. This phenomenon may occur due to the increase in water consumption or demand for summer during the month of May to September.



Resource : Selangor Water Management Authority

Figure 4.11: Sungai Selangor Dam Rainfall and Water Level 2012 to 2016

Figure 4.12 show the water level of the Sungai Tinggi Dam is in line with the rate of rainfall. Overall, there is an increase in rainfall during the northeastern monsoon for 2013 to 2016 started november and start decrease by Mac. The rainfall during northeastern monsoon is between 500 mm to 750 mm. In early May to September shows a decrease of rainfall during dry season or southwest monsoon for years 2013 to 2016. There was a sudden drop in rainfall in February 2014 during the northeast monsoon season. However, in general the dam water level is still above the critical level.

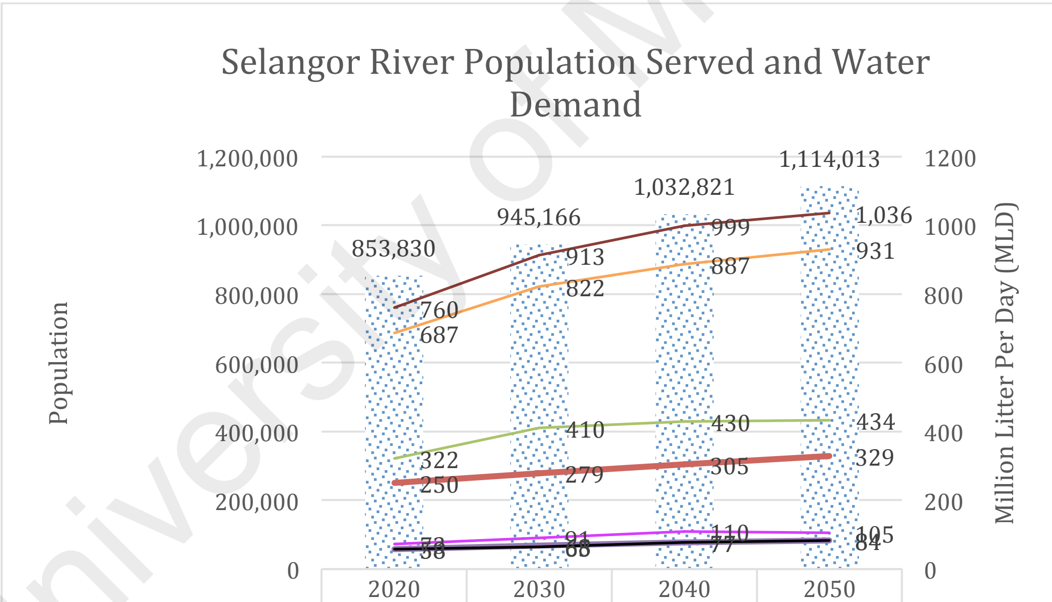


Resource : Selangor Water Management Authority

Figure 4.12: Sungai Tinggi Dam Rainfall and Water Level 2012 to 2016

4.3.1.5 Selangor River Population Served and Water Demand

Figure 4.13 shows the projection of population served and water demand for the Selangor River for 2020 to 2050. This projection is covers the area of Sabak Bernam, Hulu Selangor dam Kuala Selangor. Figure 4.13 also shows the increasing in the number of populations served between 2020 and 2050. Population served are increases from 853,830 to 1,114,013. The overall water demand projection is in line with population served growth. Figure, also shows the highest water demand is from the industry uses compare to other uses. Generally all categories of use show an increase in water demand between 2020 and 2050. The amount of water lost also increased from 73 MLD in 2020 to 105 MLD by 2050.



	2020	2030	2040	2050
Population Served	853,830	945,166	1,032,821	1,114,013
Domestic	250	279	305	329
Industrial	322	410	430	434
Commercial	58	68	77	84
Institutional	58	65	77	84
Total Uses	687	822	887	931
Losses	73	91	110	105
Demand	760	913	999	1,036

Resource : Selangor Water Management Authority

Figure 4.13: Selangor River Population Served and Water Demand

4.3.2 Klang River Basin – Batu Dam and Klang Gate Dam

4.3.2.1 Physical Characteristics And It's Location

Klang River Basin system is having a 17 rivers. The upper catchment is the place of Batu Dan and Klang Gate Dam. Batu Dam as located at Sungai Batu and Klang Gate at the Sungai Kelang. Both of dam are for flood mitigation and water supply purposes. The tributary area is Gombak for Batu Dam and Kuala Lumpur for Klang Gate Dam. The upper catchments are steep undeveloped forested area see Figure 4.14.

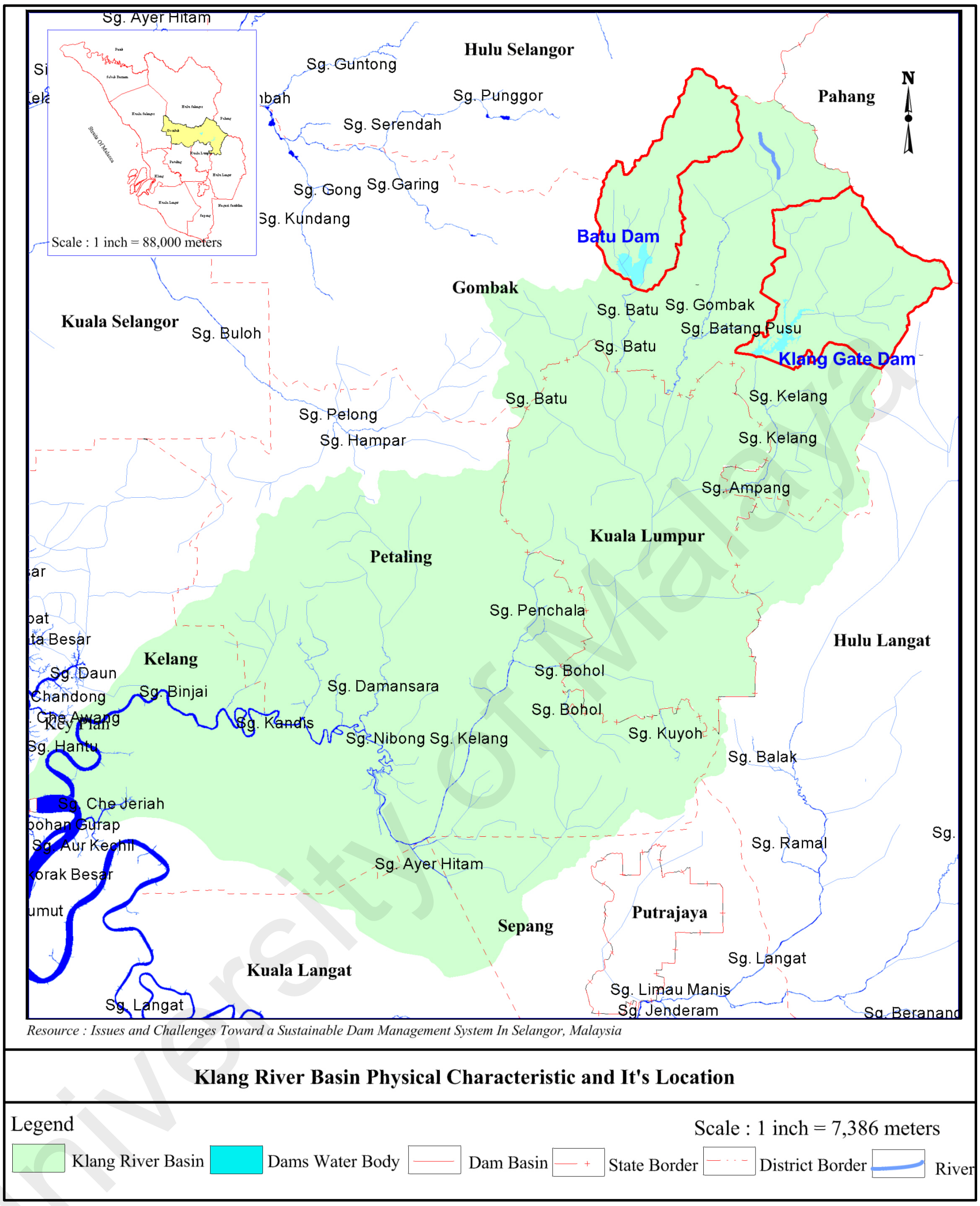


Figure 4.14: Klang River Basin Physical Characteristics And It's Location

4.3.2.2 Topographical Features

(a) ***Klang River Basin Relief***

Upper catchment covered by the high land with 300 – 600 meters, where the Batu Dam and Klang Gate Dam are located. Meanwhile, at the middle catchment there has a several area with 100 – 300 meters high and most of this area are below 60 meter. All areas at the lower catchment are at a level below 60 meters. See figure 4.15

(b) ***Klang River Basin Slope Level***

Batu Dam and Klang Gate Dam are located at the upper catchment area. At the upper of Batu Dam Basin and Klang Gate Basin the slope level is more than 25 degrees. And both are 12 degrees below. At the middle and lower catchment, all area slope level is below 12 degrees. See figure 4.16.

(c) ***Klang River Basin Geology***

Part of the upper catchment of Selangor River Basin is underlain with granitic rock (permanian – jurassic) Other part of upper-section occupied by sedimentary rock – ordivican – silurian which include, schist, phyllite, slate and limestone, minor intercalations of sandstone and volcanic. Part of the mid-section occupied by granitic rock and others part by the sedimentary rock which, carboniferous and Ordovician-Silurian. Sedimentary rock of Quaternary: marine and continental deposits: clay, silt, sand, peat with minor gravel on the coastal plains, See Figure 4.17.

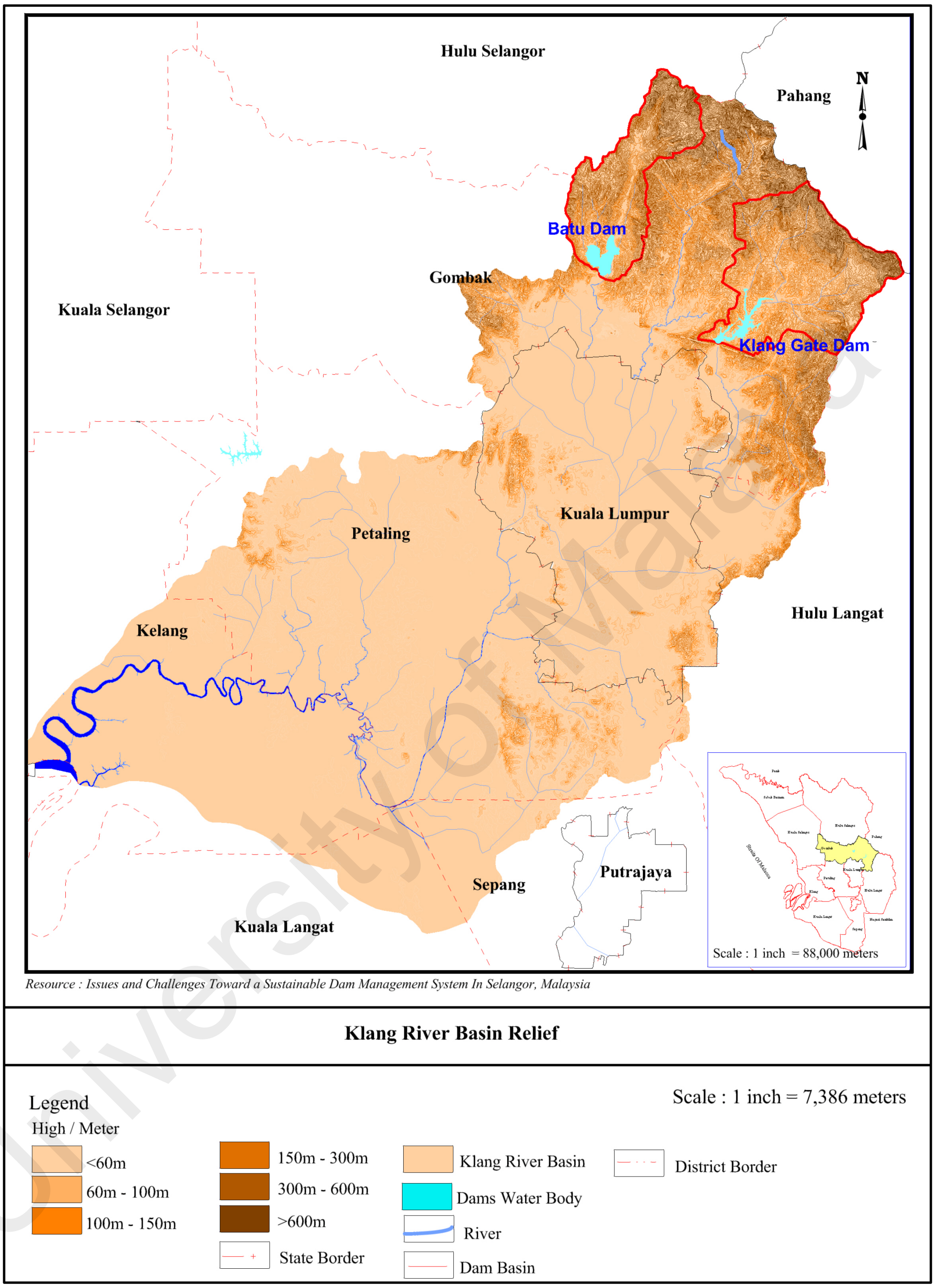


Figure 4.15: Klang River Basin Relief

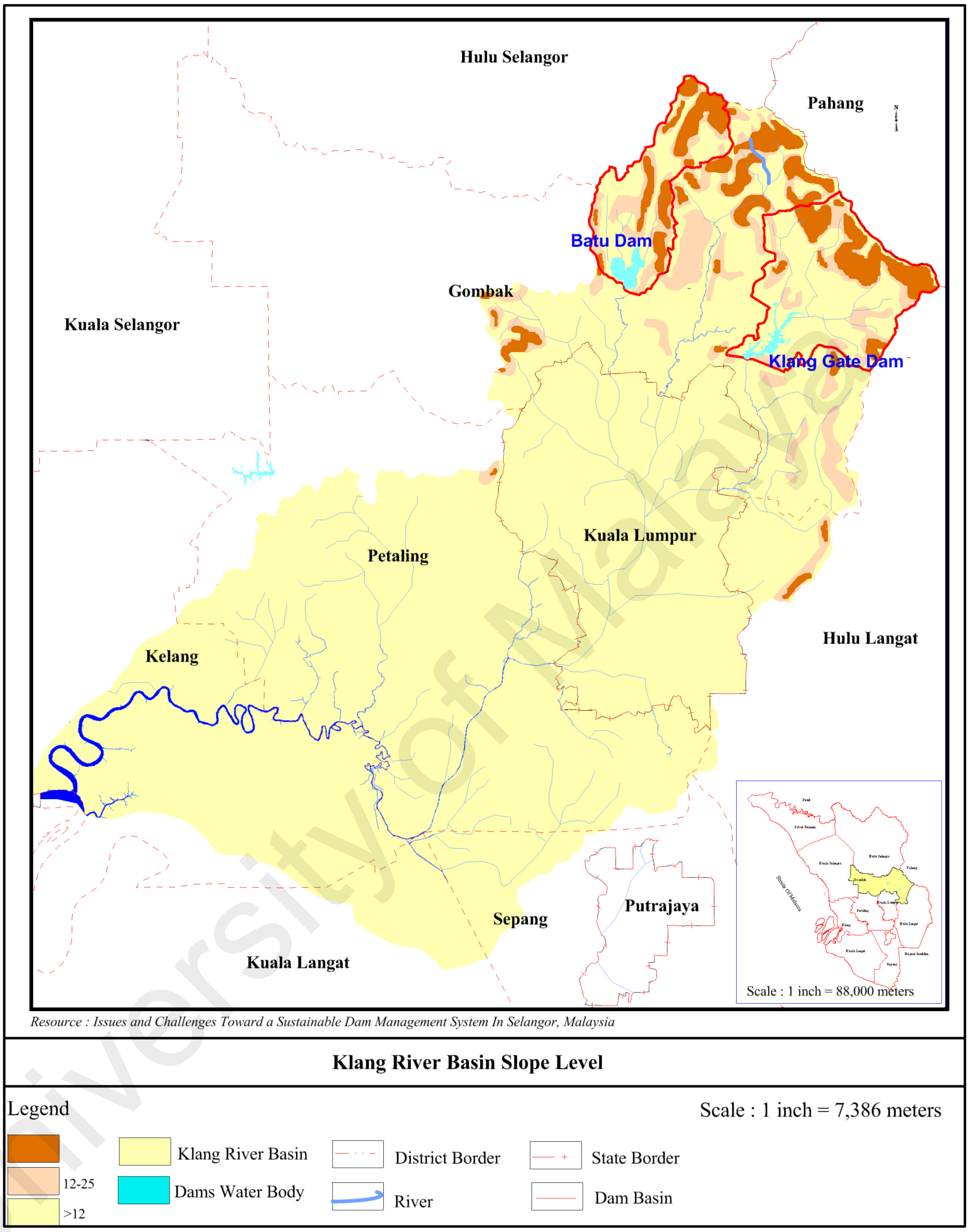


Figure 4.16: Klang River Basin Slope Level

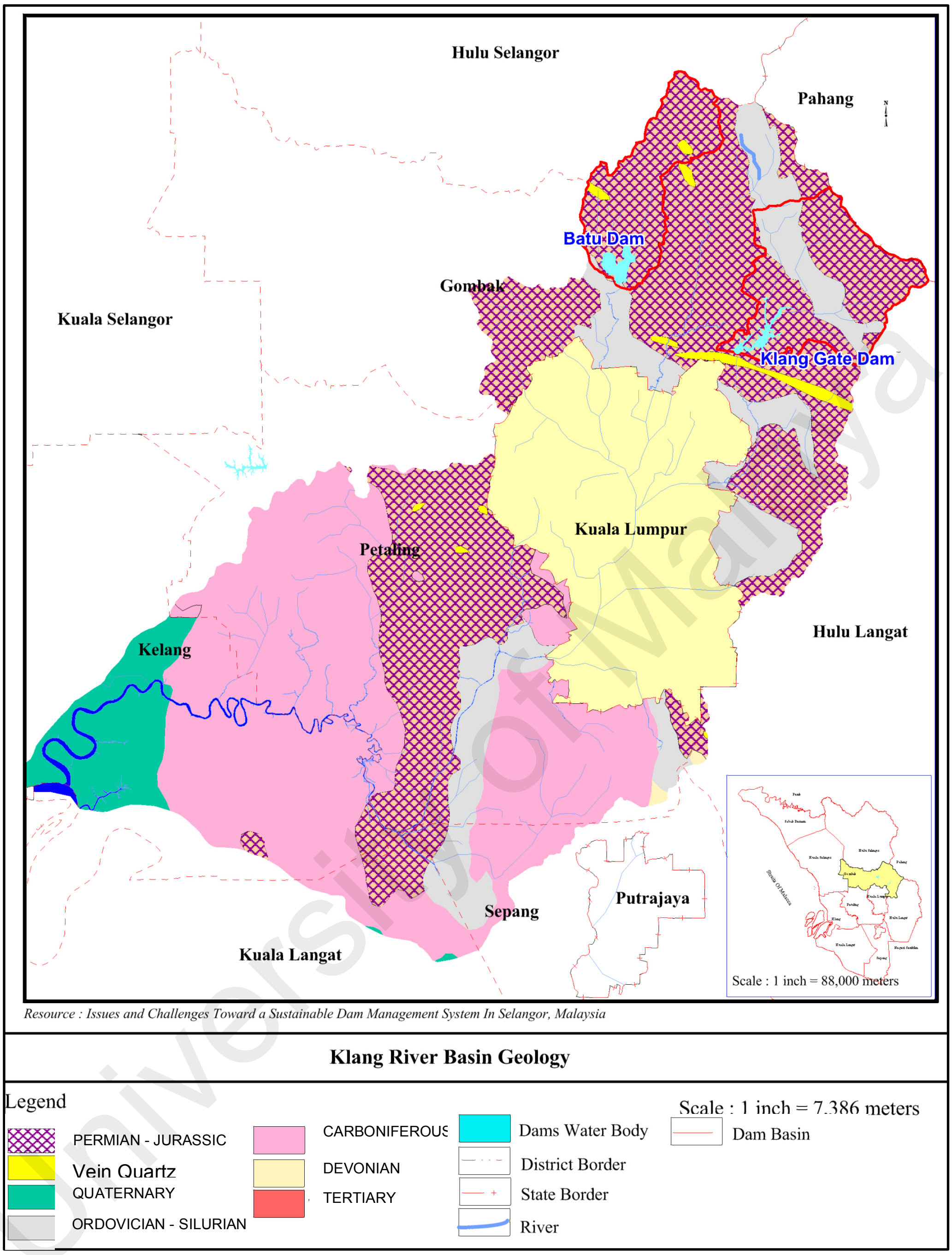


Figure 4.17: Klang River Basin Geology

4.3.2.3 Land Use

At upper catchments where are Batu Dam and Klang Gate Dam are located, the area is fully covered by forest land use. the middle catchment are the Kuala Lumpur, Petaling, Subang Jaya and Shah Alam area. This area is fully developed and high density. It also came with the lower catchment at the Klang District that fully develop with housing and industrial area, See Figure 4.18.

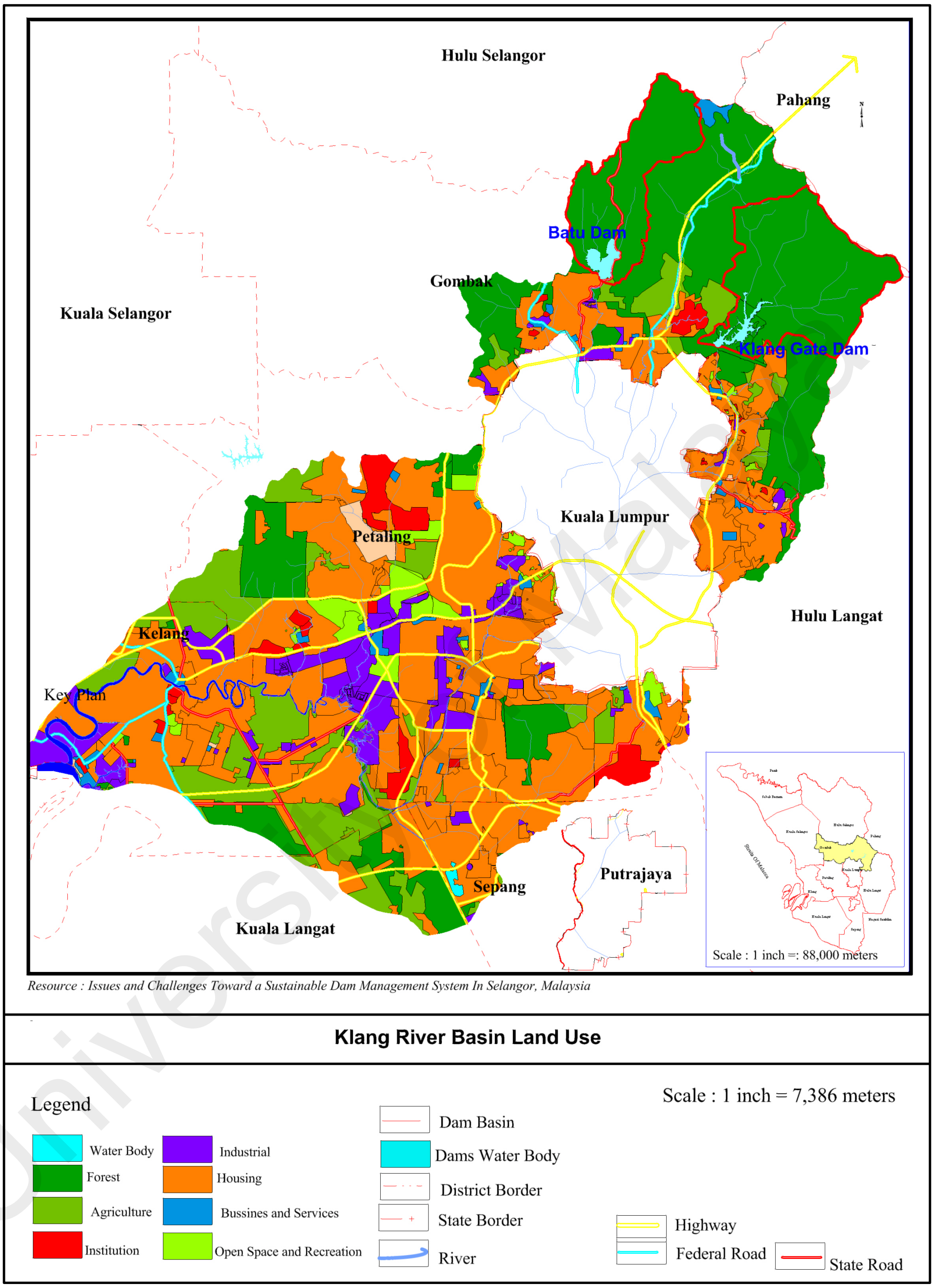


Figure 4.18: Klang River Basin Land Use

4.3.2.4 Hydrology and Meteorology

*(a) **Klang River Basin Surface Water Volume***

Integrated surface water – ground water interaction model has reveals that the all three rivers in Selangor only receive water from groundwater and does not feed the groundwater. This may be due to the fact that due to the higher in ground elevation, The ground water table always remains higher than the surface water level (SWMA, 2014). The amount of aquifer contribution to the Klang River Basin calculation show at the Table 4.6.

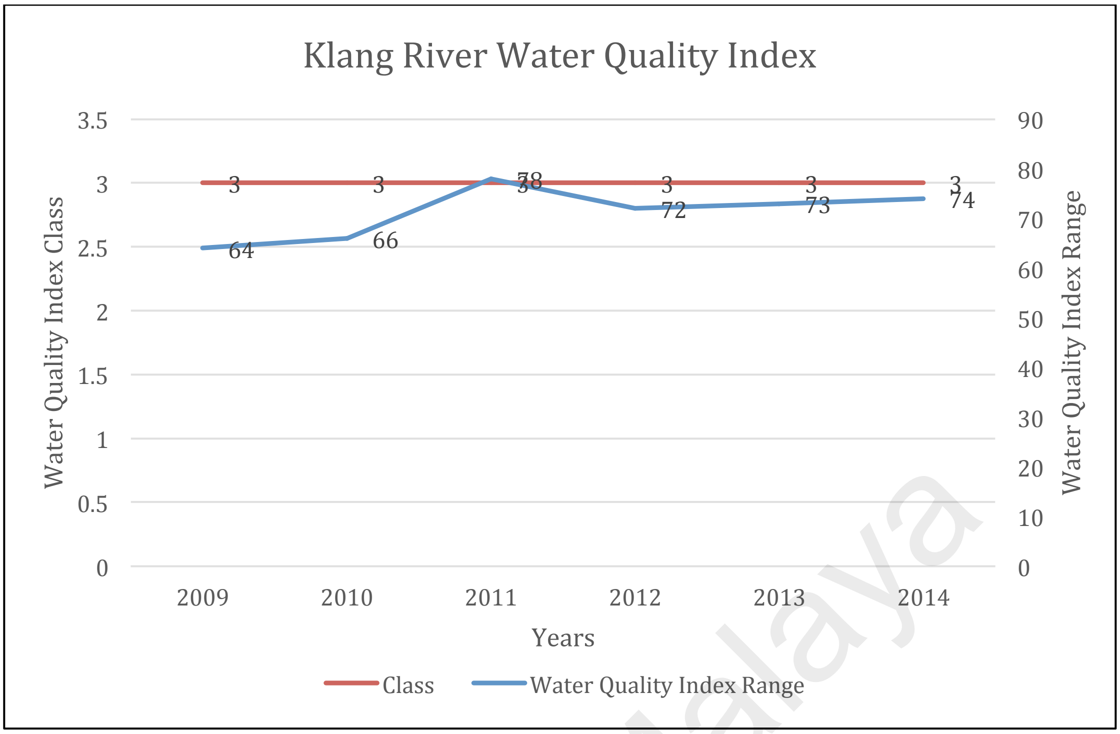
Table 4.6: Year Wise Approximately Klang River Basin Surface Water – Ground Water Interaction Volume (Mm^3)

Year	Surface Water – Ground Water Interaction Volume (Mm^3)
2008	41
2009	23
2010	38
2011	33
2012	45

(Resource : Selangor Water Management Authority. (2014). Selangor Groudwater Availability Study For SWMA Volume 1, Main Report, December 2014. Selangor.)

*(b) **Klang River Basin Surface Water Quality***

Figure 4.19 Shows the Klang River Water Quality Index reported by department of environment from 2009 to 2014. Klang River Water quality index class level from 2009 to 2014 is 3, which mean the water is clean and ideal for water supply but regular treatment is needed for that purpose. There is no change to the level classes during 2009 to 2014. But there is an increase in water quality index range from 2009 to 2011, but It‘s still under the level Partially polluted until 2014.



Sources : Department of Environment

Figure 4.19: Klang River Basin Water Quality

(c) Klang River Basin Ground Water Capacity

The upper basin and Batu Dam Basin and Klang Gate Basin occupied by ground water below 2500 gallons per hour / well at the highland area. Meanwhile, the mid-section occupied by ground water ability of 2500 – 4000 gallons per hour / well. At the coastal area is 4000 gallons per hour / well and above, See Figure 4.20.

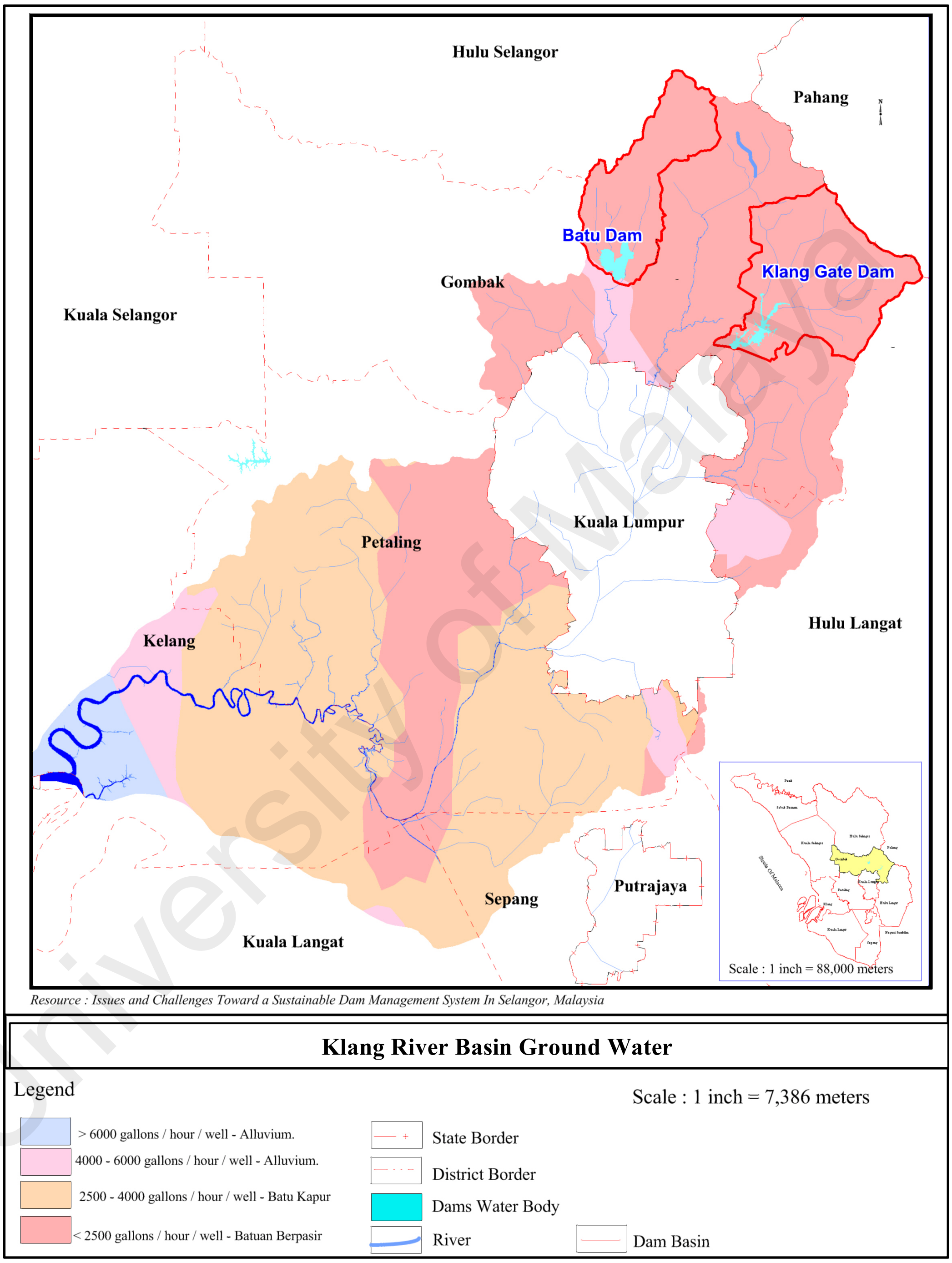
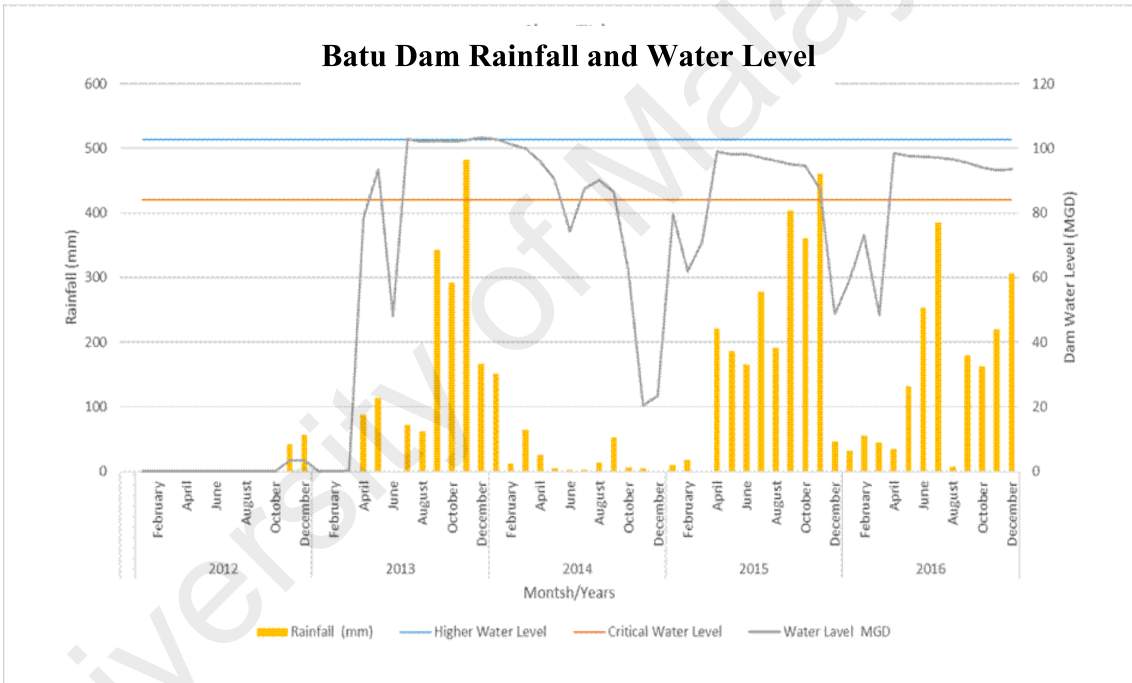


Figure 4.20: Klang River Basin Ground Water

(d) ***Batu Dam and Klang Gate Dam Meteorology***

Figure 4.21 shows the water level of the Batu Dam is in line with the rate of rainfall. Overall rainfall in the northeast monsoon catchment area showed an increase for 2013, 2015 and 2016. Because of the northeastern monsoon is the wind that damps the humid season. Except for 2014 alone shows a decrease in rainfall during the northeast monsoon. The rainfall rates during the southwest monsoon show a reduction in rainfall rates between May to September for 2013 to 2016. However, Batu dam water level is still above the critical level.

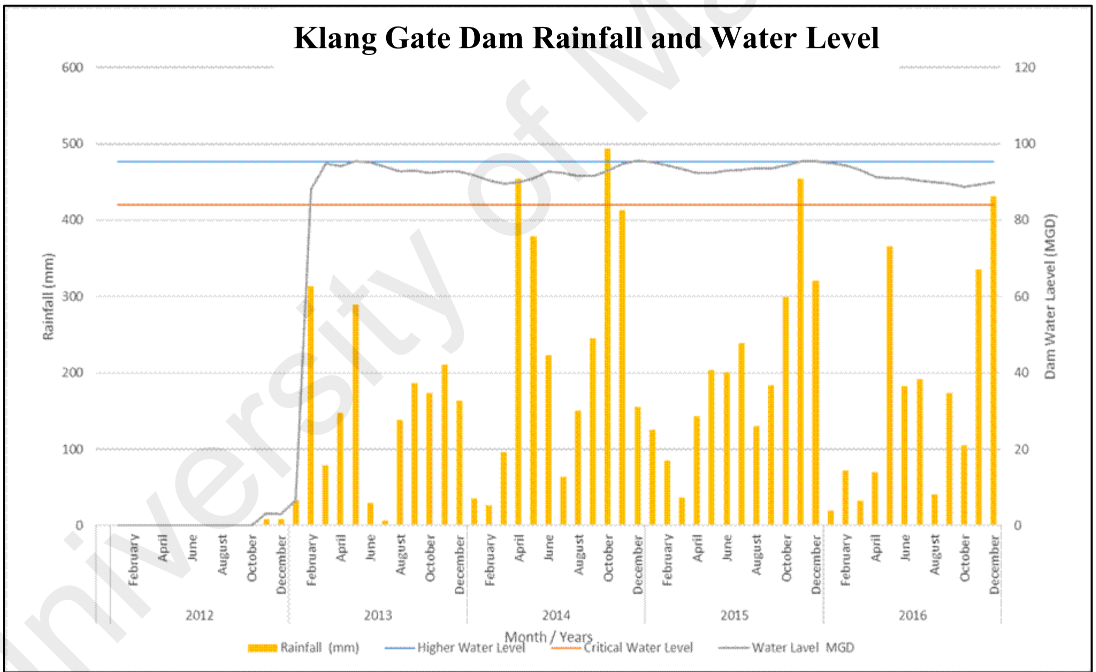


Resource : Selangor Water Management Authority

Figure 4.21: Batu Dam Rainfall and Water Level Years 2012 to 2016

Same with others dam in Selangor, Klang Gate Dam also experiences the dry season in year 2012. Figure 4.22 shows the water level of the dam is in line with the rate of rainfall. Overall rainfall in the northeast monsoon catchment area showed an increase for 2014, 2015 and 2016. Because of the northeastern monsoon is the wind that damps the humid season. However, in 2013, the rate of rainfall decreased even during the northeast monsoon season.

The rainfall rates during the southwest monsoon Showing increases and decreases in rainfall rates between May to September for 2014 to 2016. Klang Gate Dam water level is still above the critical level. Even in the dry season of the southwest monsoon.

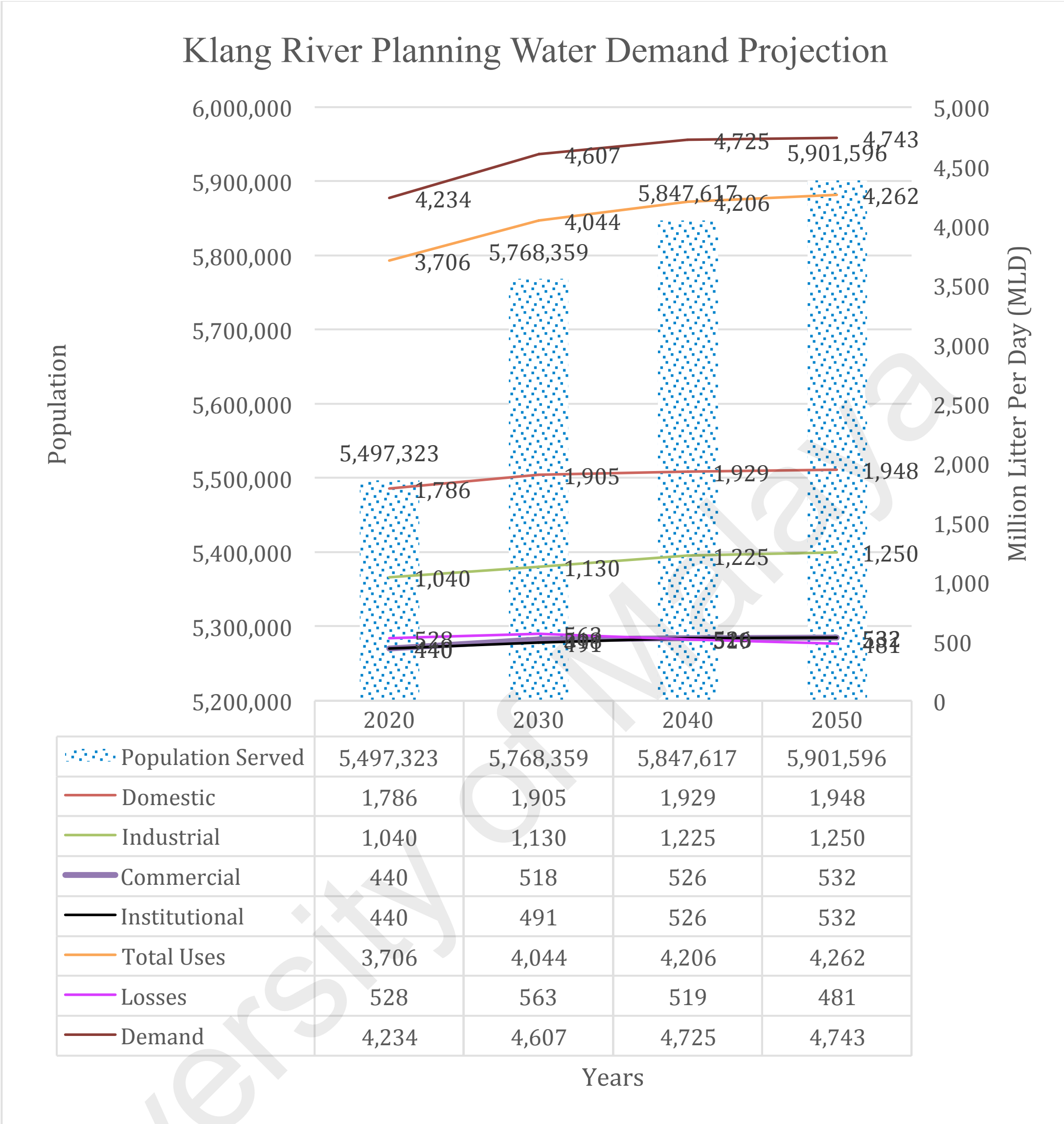


Resource : Selangor Water Management Authority

Figure 4.22: Klang Gate Dam Rainfall and Water Level Years 2012 to 2016

4.3.2.5 Population Served and Water Demand

The diagramFigure 4.23 shows the projection of population served and water demand for the Klang River for 2020 to 2050. This projection is covers the area of Kuala Lumpur, Petaling dan Gombak. It shows the increasing in the number of populations served between 2020 and 2050. Population served are increases from 5,497,323 to 5,901,596. The overall water demand projection is in line with population served growth. Figure, also shows the highest water demand is from the domestic uses compare to other uses. Generally all categories of use show an increase in water demand between 2020 and 2050. The amount of water lost also increased from 528 MLD in 2020 to 563 MLD by 2030, and decrease on from 519 MLD to 481 MLD on 2040 and 2050.



	2020	2030	2040	2050
Population Served	5,497,323	5,768,359	5,847,617	5,901,596
Domestic	1,786	1,905	1,929	1,948
Industrial	1,040	1,130	1,225	1,250
Commercial	440	518	526	532
Institutional	440	491	526	532
Total Uses	3,706	4,044	4,206	4,262
Losses	528	563	519	481
Demand	4,234	4,607	4,725	4,743

Resource : Selangor Water Management Authority

Figure 4.23: Klang River Population Served and Water Demand

4.3.3 Langat River Basin – Langat Dam and Semenyih Dam

4.3.3.1 Physical Characteristics And It's Location

Langat Dam and Semenyih Dam are located at the upper catchment in deferent river. Upper middle is in the area of Hulu Lamgat District. At the middle catchment, there has no dam. Middle catchment of this basin is covered Putrajaya and Sepang District. Meanwhile, the lower catchment is at the Kuala Langat District. Langat Dam serves to control the quantity and water level of the Langat river, for water intake at Sungai Langat, Batu 11 Cheras, Sungai Serai, Sungai Pangson, Sungai Lolo and Bukit Tampoi Water treatment Plant. Area served is Hulu Langat and Cheras. Semenyih Dam serves to control the quantity and water level of Semenyih river, for Jenderam Hilir water intake for Sungai Semenyih Water Treatment Plant at Dengkil. Served area is Putrajaya, Hulu Langat, Kuala Langat, Sepang, Petaling, See Figure 4.24.

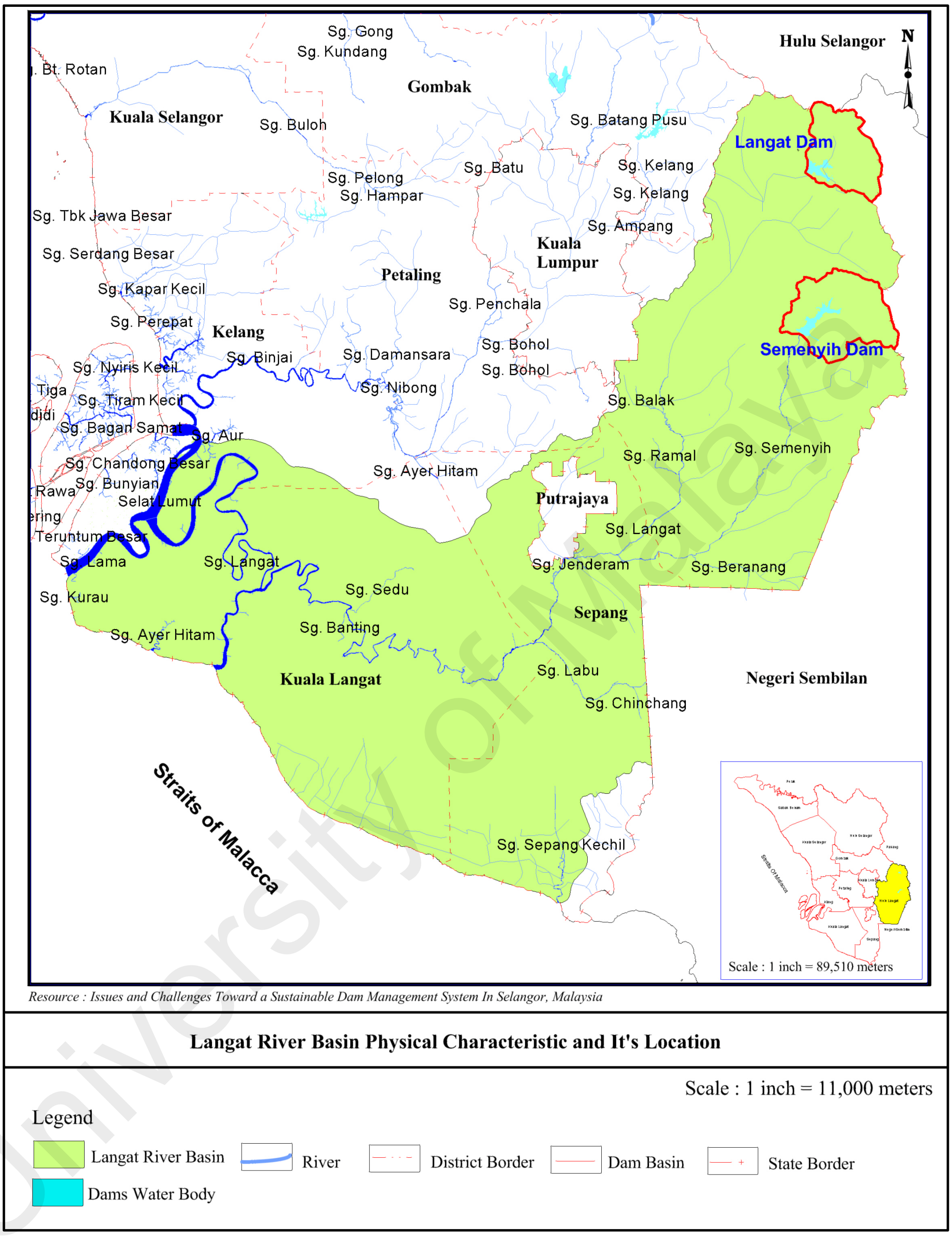


Figure 4.24: Langat River Basin Physical Characteristics And It's Location

4.3.3.2 Topographical Features

*(a) **Langat River Basin Relief***

Langat Dam and Semenyih Dam are located at the upper catchment area. The level or relief at the upper catchment area is between 60 meters to 600 meter. But most area is at level a 100 meters above. Meanwhile middle upper most of the area are below 60 meters 9flat land) its cover Putrajaya and Sepang area, there only a bit of high area at Sepang with 100 to 150 meter. All are at lower catchment that cover a Kuala Langat District area is an at a lower level below 60 meters. See Figure 4.25.

*(b) **Langat River Basin Slope Level***

The highest slope level is only located at the upper catchment where Langat dam and semenyih dam are Located. The slope level at the upper catchment is between 12 to 25 degree. Have no slope level above 12 degrees at the middle and lower catchment. See Figure 4.26.

*(c) **Langat River Basin Geology***

Base on the Figure of 4.27 much of the upper catchment of Selangor River Basin is underlain with granitic rock (permanian – jurassic) with an isolation of sedimentary rock of Ordovician-silurian. Part of mid-section occupied by sedimentary rock of Devonian (phyllite, schist and slate : limestone and sandstone are locally prominent. Some interbeds of conglomerate, chert and rare volcanic). Other part of the mid-section occupied by sedimentary rock of carboniferous (phyllite, slate, shale and sandstone: argillaceous rock are commonly carbonaceous. locally prominent development of limestone Volcanic of acid to intermediate composition are locally present). Quaternary (marine and continental deposits: clay, silt, sand, peat with minor gravel), on the coastal plains.

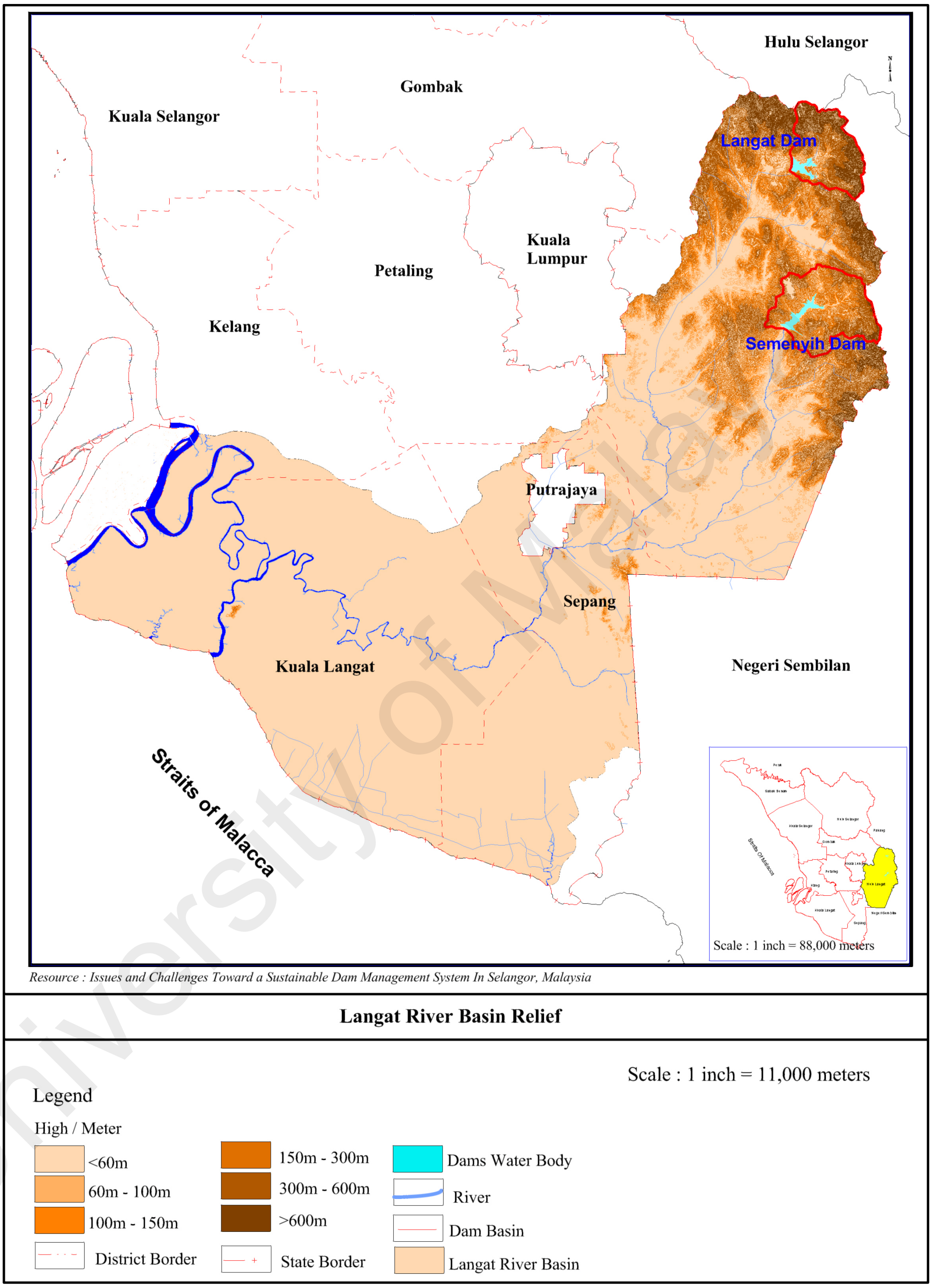


Figure 4.25: Langat River Basin Relief

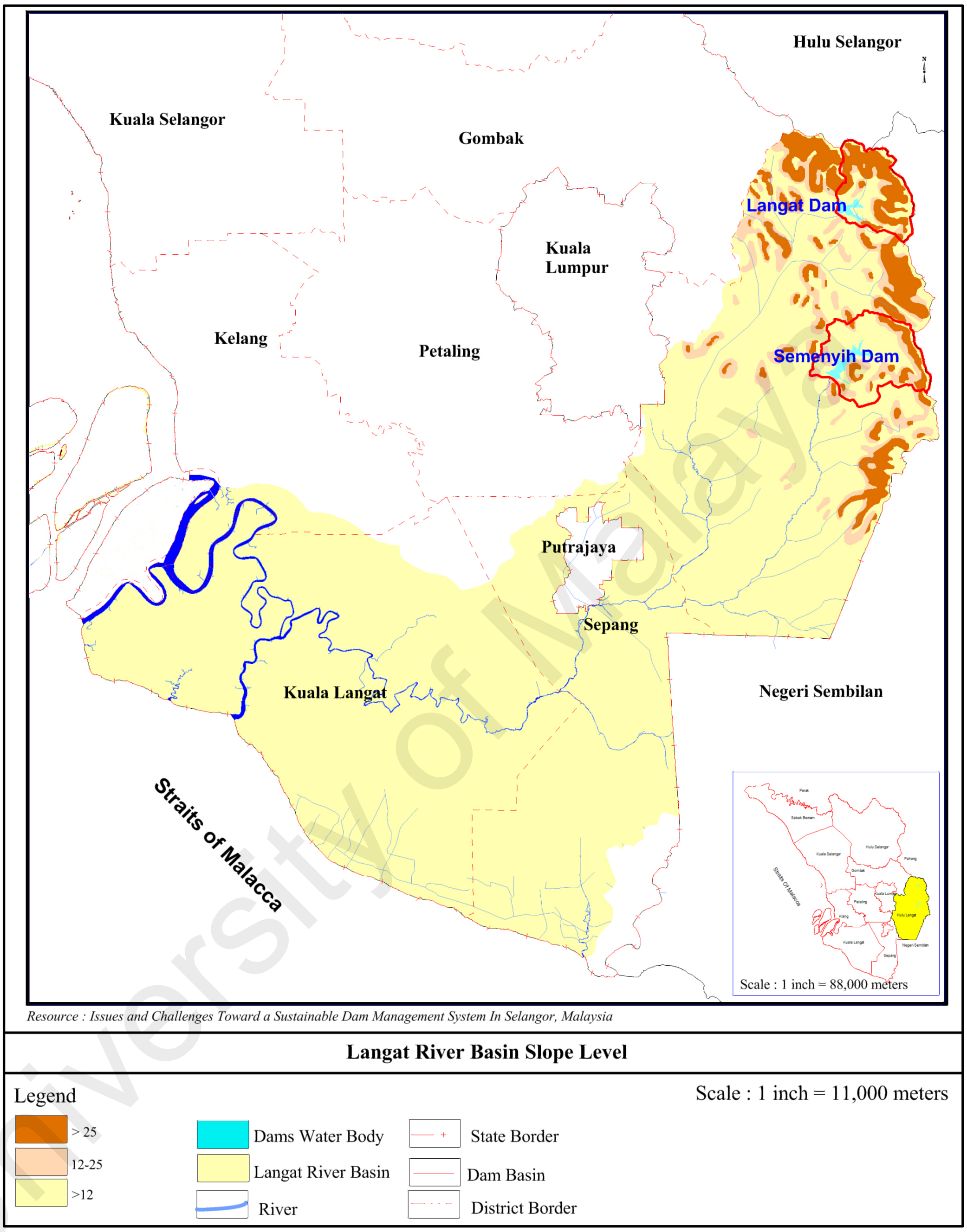


Figure 4.26: Langat River Basin Slope Level

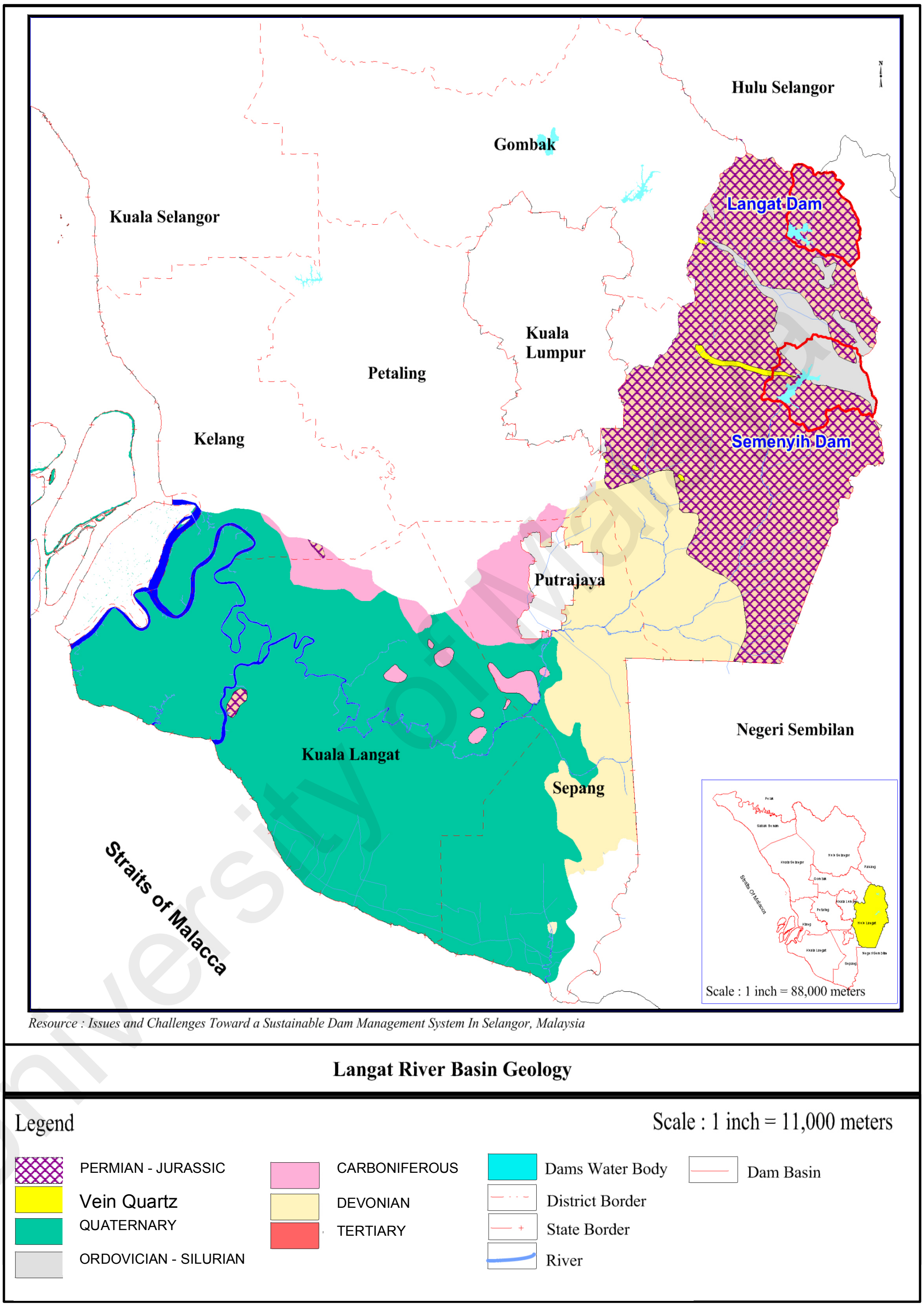


Figure 4.27: Langat River Basin Geology

4.3.3.3 Land Use

Upper catchment area is covered by forest and agriculture land use. All dam basin area for Langat and Semenyih Dam is covered by a forest land. The middle catchment is 2nd Klang Valley area that covered the rapidly development area such as Putrajaya, Cyberjaya, Sepang, KLIA, and Kajang. Where this area has a lot of activities and multi land use, such as housing, business, industrial, institution and some of the agriculture area. At the lower catchment, most of the areas, are covered by an agriculture land use, some forest, housing and industrial area. See Figure 4.28.

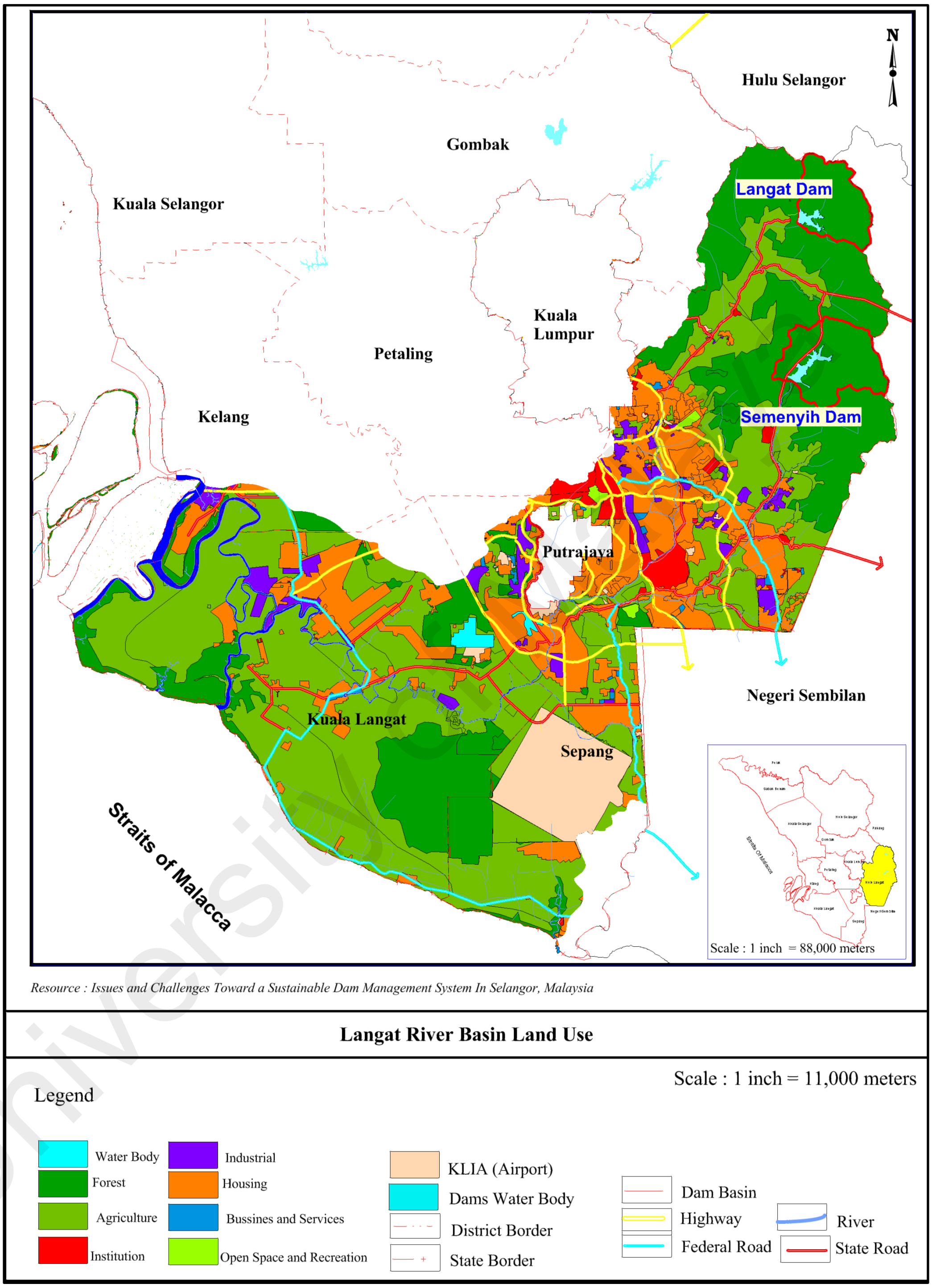


Figure 4.28: Langat River Basin Land Use

4.3.3.4 Hydrology and Meteorology

(a) Langat River Basin Surface Water Volume

Integrated surface water – ground water interaction model has reveals that the all three rivers in Selangor only receive water from groundwater and does not feed the groundwater. This may be due to the fact that due to the higher in ground elevation, The ground water table always remains higher than the surface water level (SWMA, 2014). The amount of aquifer contribution to the Langat River Basin calculation show at the Table 4.7.

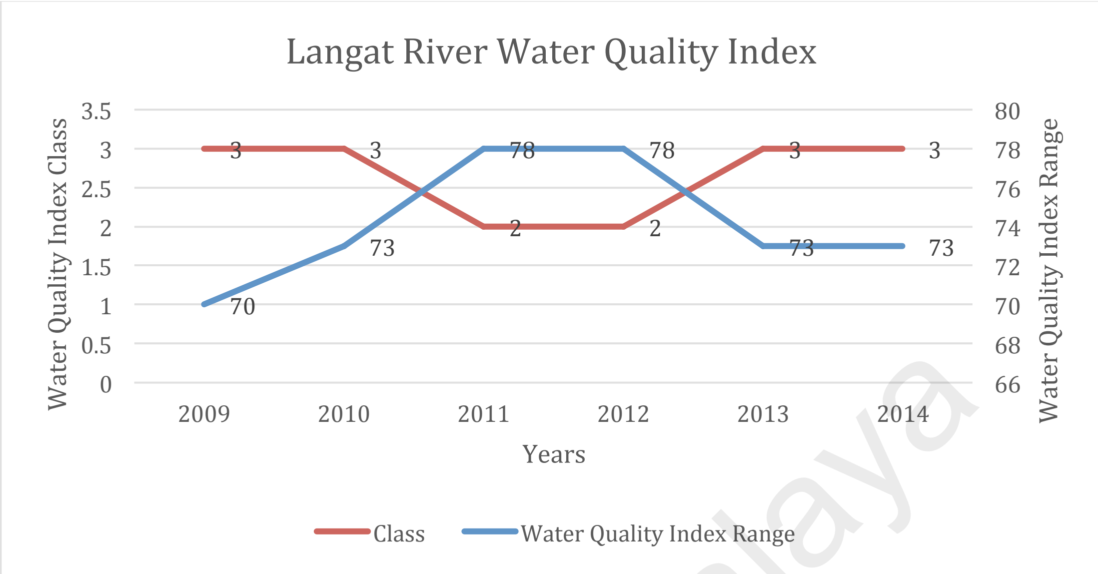
Table 4.7: Year Wise Approximately Langat River Basin Surface Water – Ground Water Interaction Volume (Mm^3)

Year	Surface Water – Ground Water Interaction Volume (Mm^3)
2008	74
2009	59
2010	61
2011	52
2012	72

(Resource : Selangor Water Management Authority. (2014). Selangor Groudwater Availability Study For SWMA Volume 1, Main Report, December 2014. Selangor.)

(b) Langat River Basin Water Quality

Figure 4.29 Shows the Langat Water Quality Index reported by department of environment from 2009 to 2014. Langat River Water quality index class level from 2009 to 2010 is 3, which mean the clean status, suitable for water supply but further treatment is required for that purpose. The level of Langat Water Quality Index class for Langat River is increase to 2 in year 2011 to 2012 and decrease to level 3 in year 2013 to 2014. Figure 4.29 Show there have an increase in water quality index range from 2009 to 2011. It‘s from partially polluted in year 2009 to 2010 to clean level in year 2011 and 2012. But in year 2013 to 2014 the Langat River is decrease to partially polluted, with water quality index range at a range 73



Sources : Department of Environment

Figure 4.29: Langat River Basin Water Quality

(c) Langat River Basin Ground Water Capacity

Since the upper catchment and Langat and Semenyih Dam basin area is a highland, the ground water capacity for this area is below 2500 gallons per hour / well. At the mid-section have three levels of ground water capacity, 1st is below 2500 gallons per hour / well, 2nd 2500 to 4000 gallon per hour / well and 3rd is 4000 to 6000 gallon per hour / well. All lower catchment at Kuala Langat area has a ground water capacity of 6000 gallons per hour / well and above. See Figure 4.30.

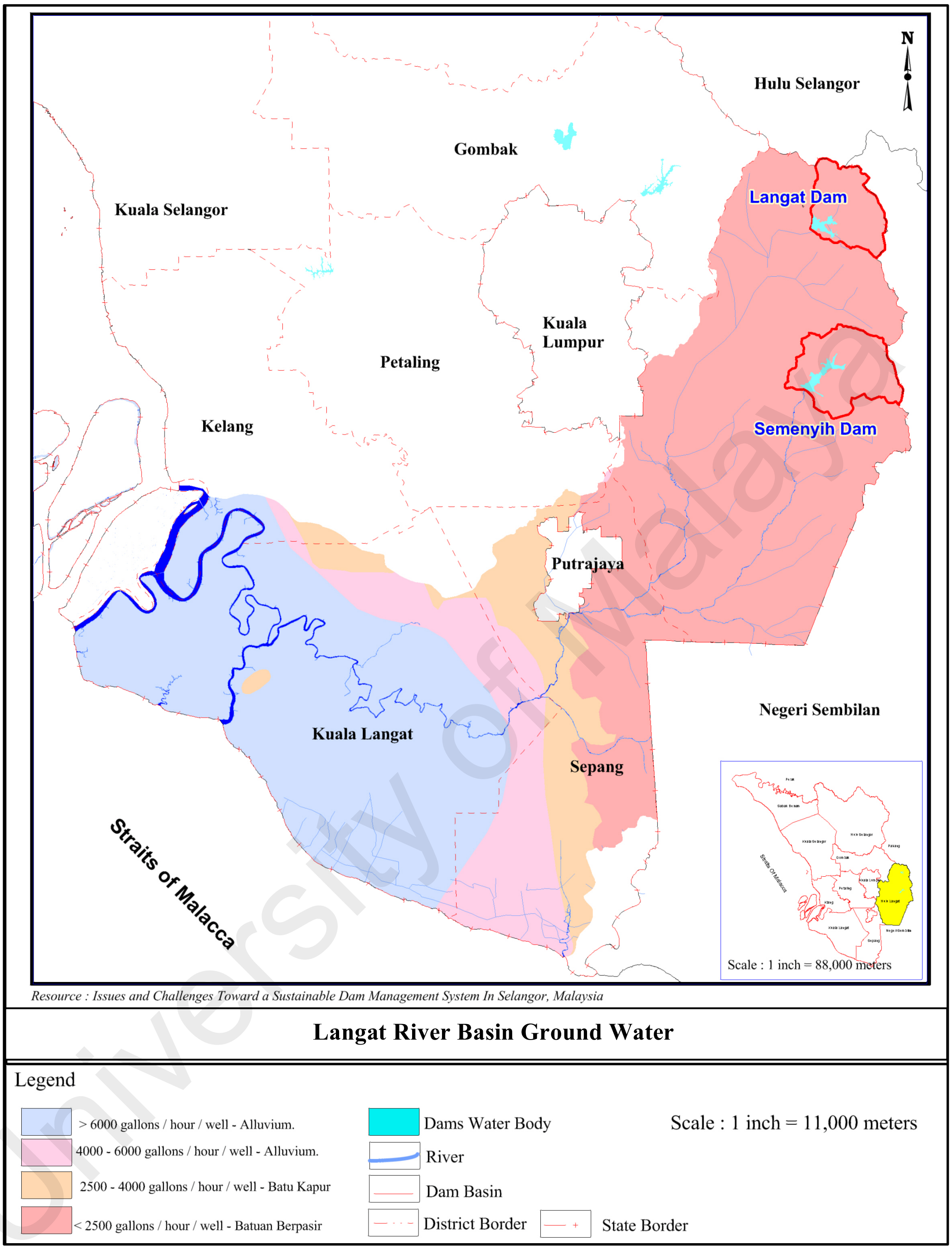
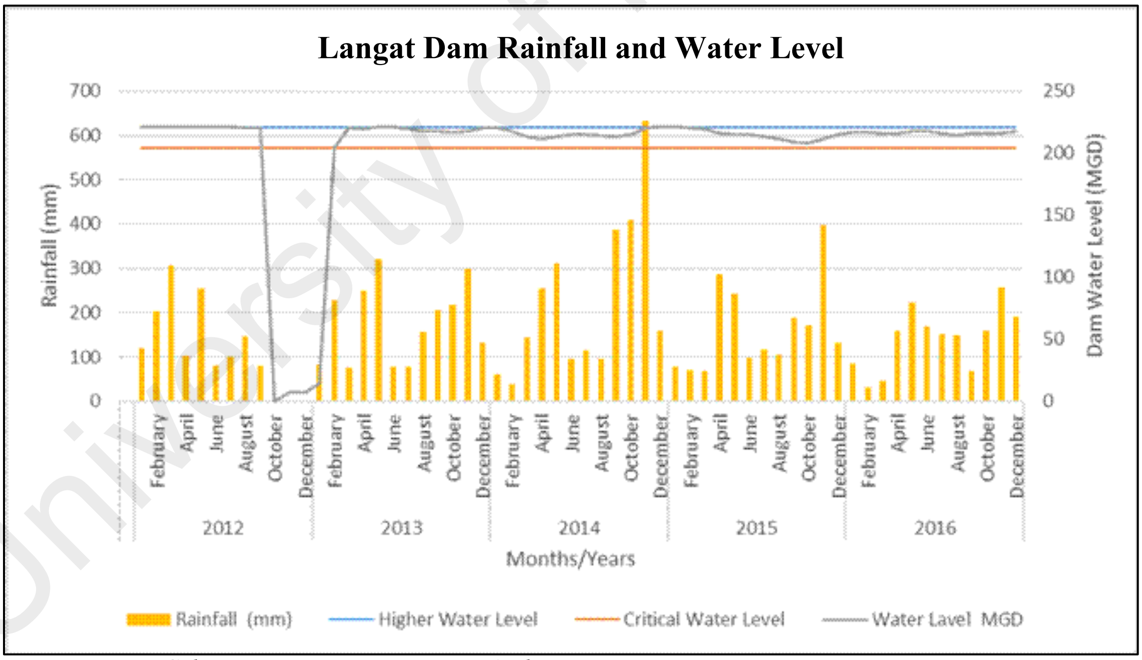


Figure 4.30: Langat River Basin Ground Water

(d) Langat Dam and Semenyih Dam Meteorology

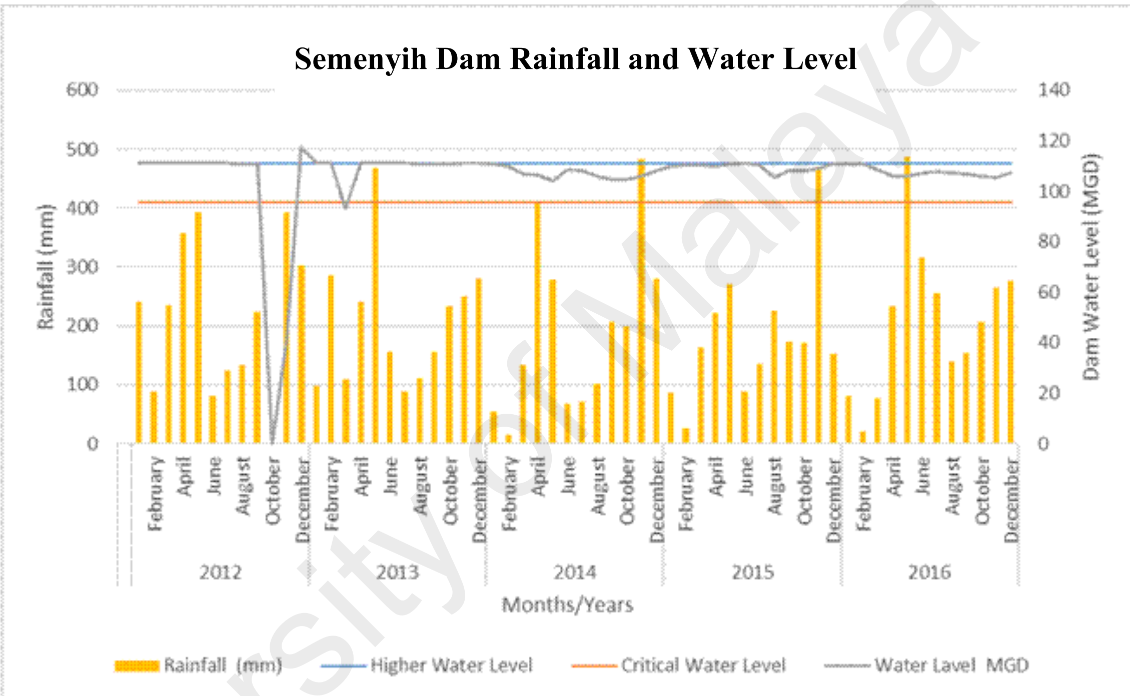
Figure 4.31 shows the water level of the Langat Dam is in line with the rate of rainfall. The highest rainfall is in November 2014, which is during the northeast monsoon. Overall, there is an increase in rainfall during the northeastern monsoon for 2013 to 2016. 2012 shows a reduction in rainfall during the northeast monsoon season due to lack of data or information. SWMA are not perform data collection for the months of October and November 2013. While the southwest monsoon, between May to September for 2012 to 2016, shows less rainfall rates as the southwest monsoon brings dry seasons. This clearly demonstrates the monsoon winds affecting the rate of rainfall in the dam area. However, in general the dam water level is still above the critical level.



Resource : Selangor Water Management Authority

Figure 4.31: Langat Dam Rainfall and Water Level 2012 to 2016

Figure 4.32 shows the water level of the Semenyih Dam is in line with the rate of rainfall. Overall, there is an increase in rainfall during the northeastern monsoon for 2013 to 2016 started november and start decrease by Mac. High rainfall rates also occur during dry seasons, southwest monsoon between April to Jun for years 2013 to 2016, between 400 mm to 490 mm. However, in general the dam water level is still above the critical level.

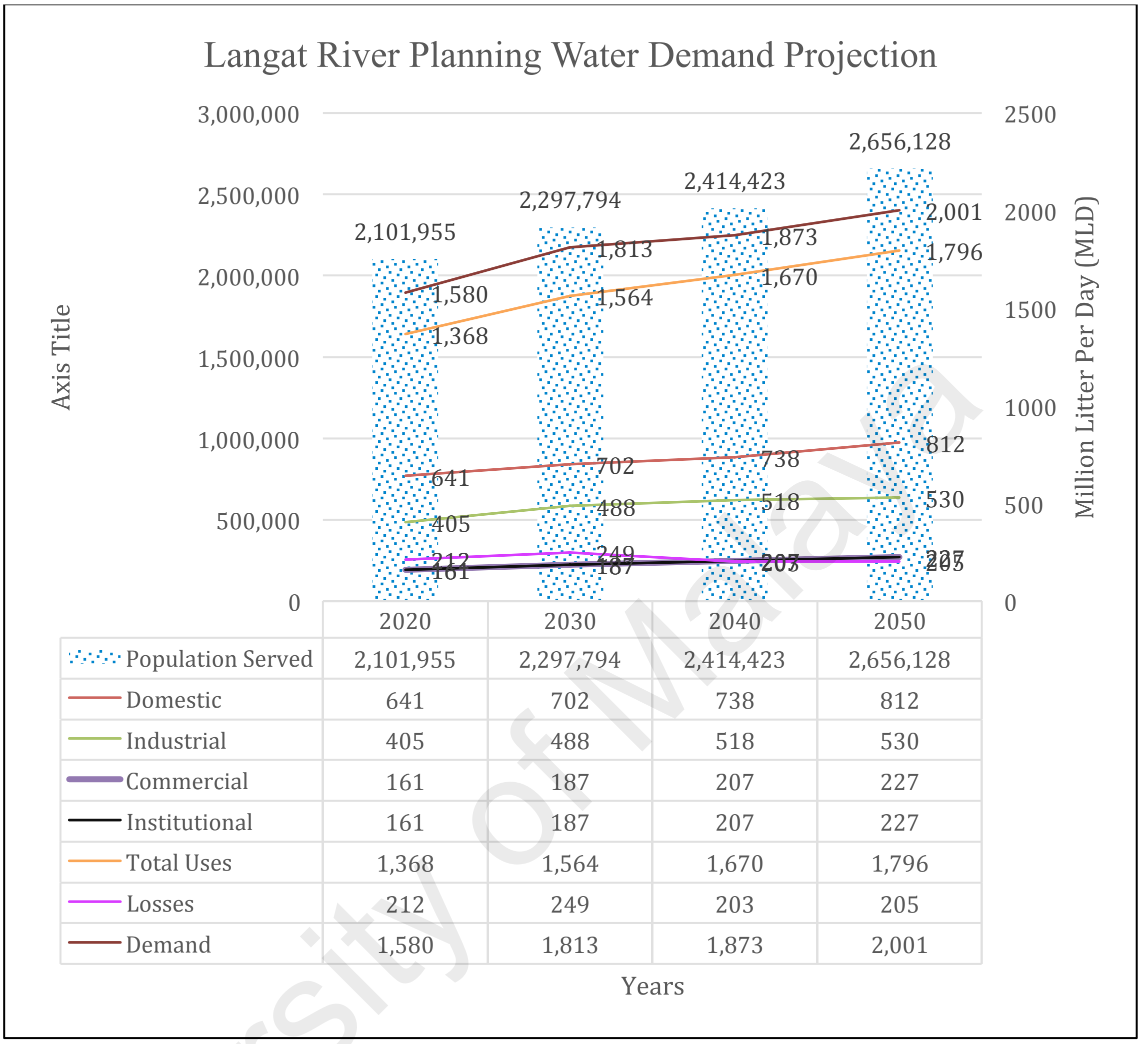


Resource : Selangor Water Management Authority

Figure 4.32: Semenyih Dam Rainfall and Water Level 2012 to 2016

4.3.3.5 Population Served and Water Demand

The diagram shows the projection of population served and water demand for the Langat River for 2020 to 2050. This projection is covers the area of Kuala Langat, Hulu Langat dan Kuala Sepang. Figure 4.33 shows the increasing in the number of populations served between 2020 and 2050. Population served are increases from 2,101,955 to 2,656,128. The overall water demand projection is in line with population served growth. Figure, also shows the highest water demand is from the domestic uses compare to other uses. Generally all categories of use show an increase in water demand between 2020 and 2050. The amount of water lost also increased from 212 MLD in 2020 to 249 MLD by 2030, and decrease on 2040 with 203 MLD and expected increase in 2050 with 205 MLD.



Years	2020	2030	2040	2050
Population Served	2,101,955	2,297,794	2,414,423	2,656,128
Domestic	641	702	738	812
Industrial	405	488	518	530
Commercial	161	187	207	227
Institutional	161	187	207	227
Total Uses	1,368	1,564	1,670	1,796
Losses	212	249	203	205
Demand	1,580	1,813	1,873	2,001

Figure 4.33: Langat River Population Served and Water Demand

4.3.4 Buloh River Basin – Tasek Subang Dam

4.3.4.1 Physical Characteristics And It's Location

Tasek Subang Dam is located in the Buloh River Basin. Tasek Subang Dam. Tasek Subang dam is used to control the quantity of Sungai Subang water levels for North-Hummock Water Treatment Plant in Mukim Bukit Raja. Tasek Subang Dam is located in the administrative area of the Shah Alam City Council Petaling District. Tasek Subang Dam Water Catchment area is bordered by Klang and Kuala Selangor District. The served area is Kapar and Meru. There have been three (3) in Buloh River Basin which is Subang, Pelong and Boluh river. Tasek Subang Dam is located at the upper catchment area. See figure 4.34.

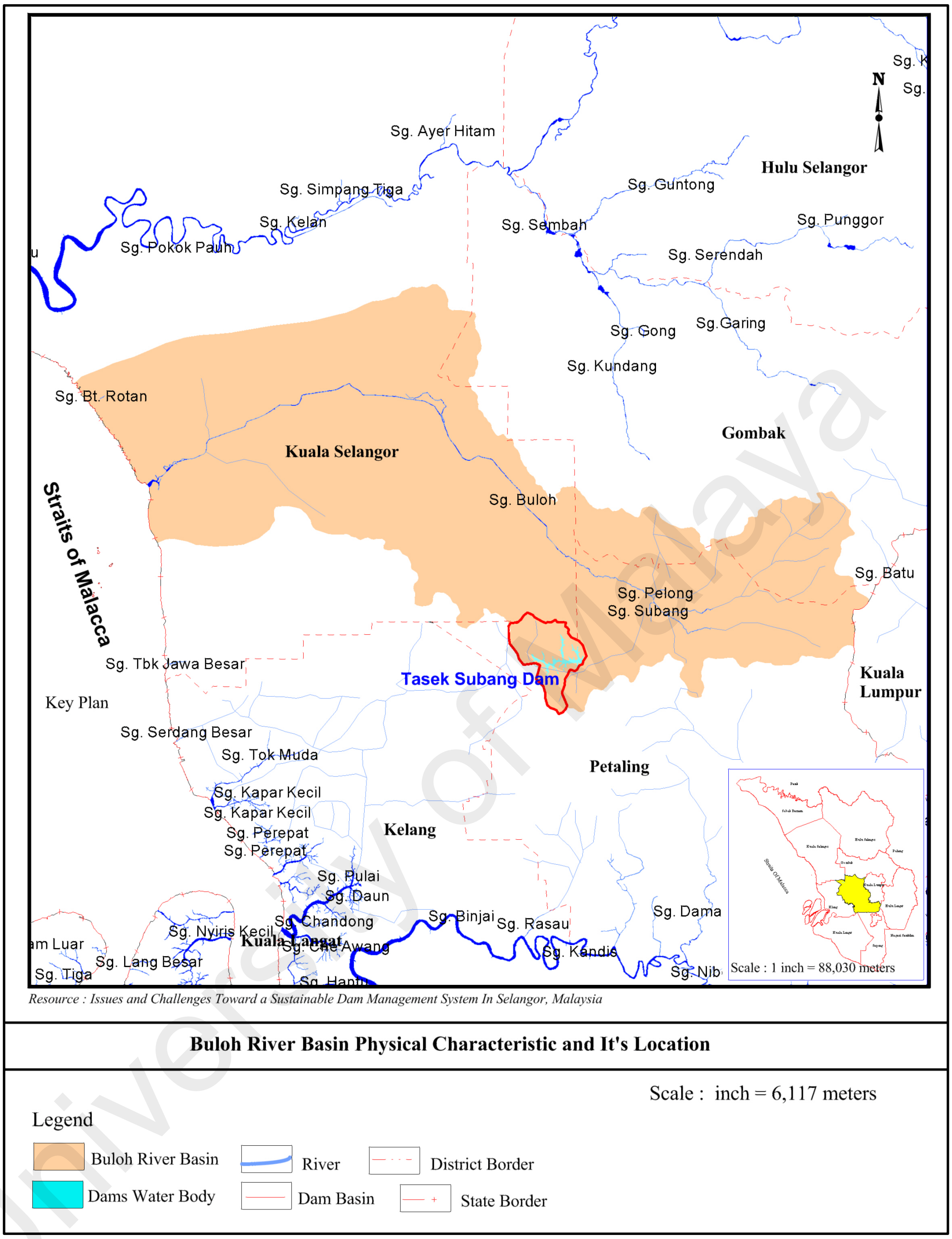


Figure 4.34: Buloh River Basin Physical Characteristics And It's Location

4.3.4.2 Topographical Features

(a) ***Buloh River Basin Relief***

There only small portion of the high level in Buloh River Basin. Upper catchment highest level is between 150 meter to 300 meter. Both of the area are below 60 meters high especially at the middle and the lower catchment. See figure 4.35.

(b) ***Buloh River Basin Slope Level***

All area in middle and lower catchment has slope level below 12 degrees. Meanwhile, only small area in the upper basin has a slope level between 12 to 25 degrees. Tasek Subang Dam Basin has a slope level below 12 degrees. See figure 4.36.

(c) ***Buloh River Basin Geology***

Part of the upper catchment of Selangor River Basin is underlain with granitic rock (permanian – jurassic). Other part of the upper-section occupied by sedimentary rock of carboniferous (phyllite, slate, shale and sandstone: argillaceous rock are commonly carbonaceous. locally prominent development of limestone Volcanic of acid to intermediate composition are locally present). Part of mid-section occupied by sedimentary rock of carboniferous and Ordovician-silurian (schist, phyllite, salte and limestone. minor intercalations of sandstone and volcanic). Quaternary (marine and continental deposits: clay, silt, sand, peat with minor gravel), on the coastal plains. See Figure 4.37.

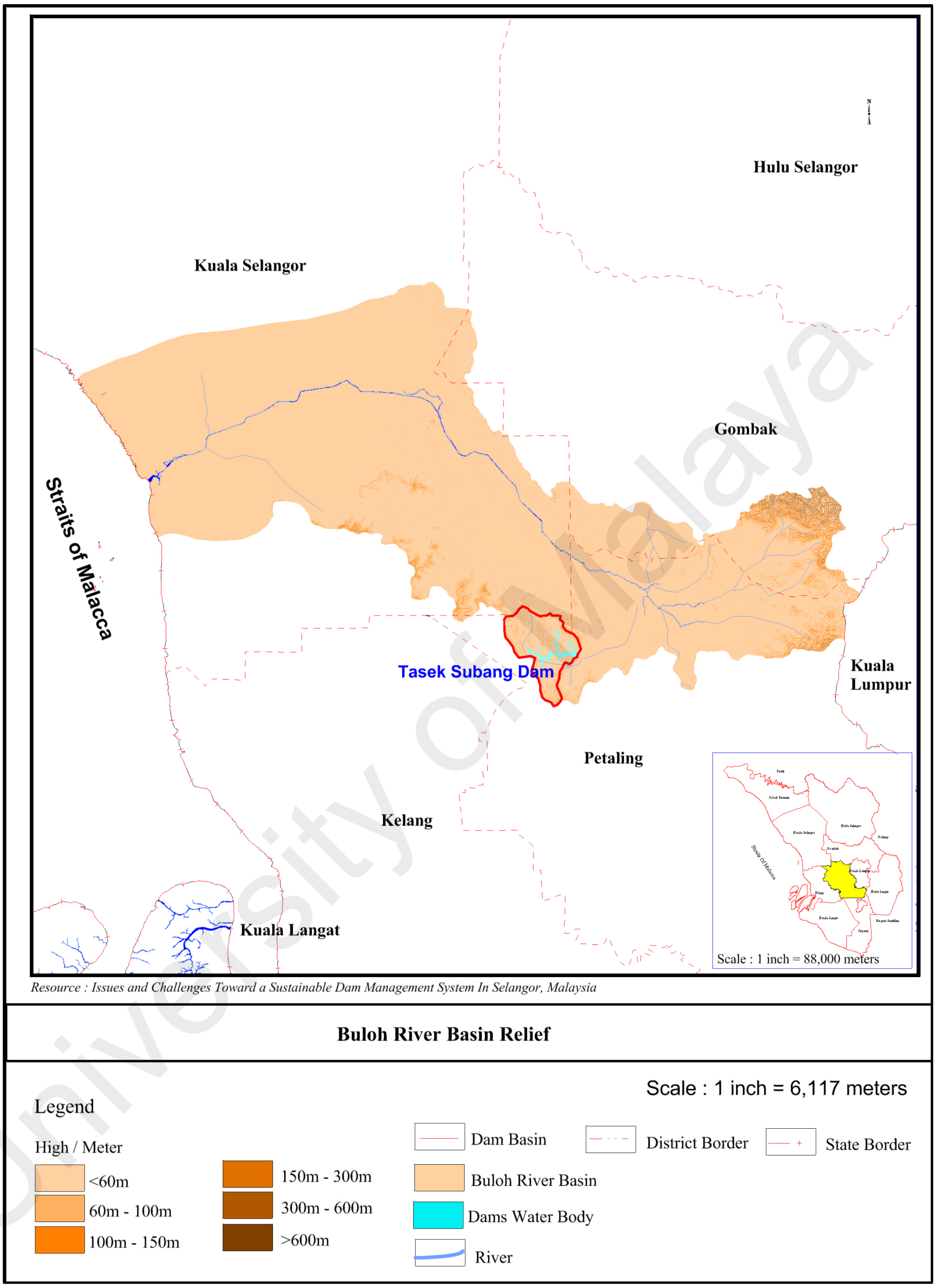


Figure 4.35: Buloh River Basin Relief

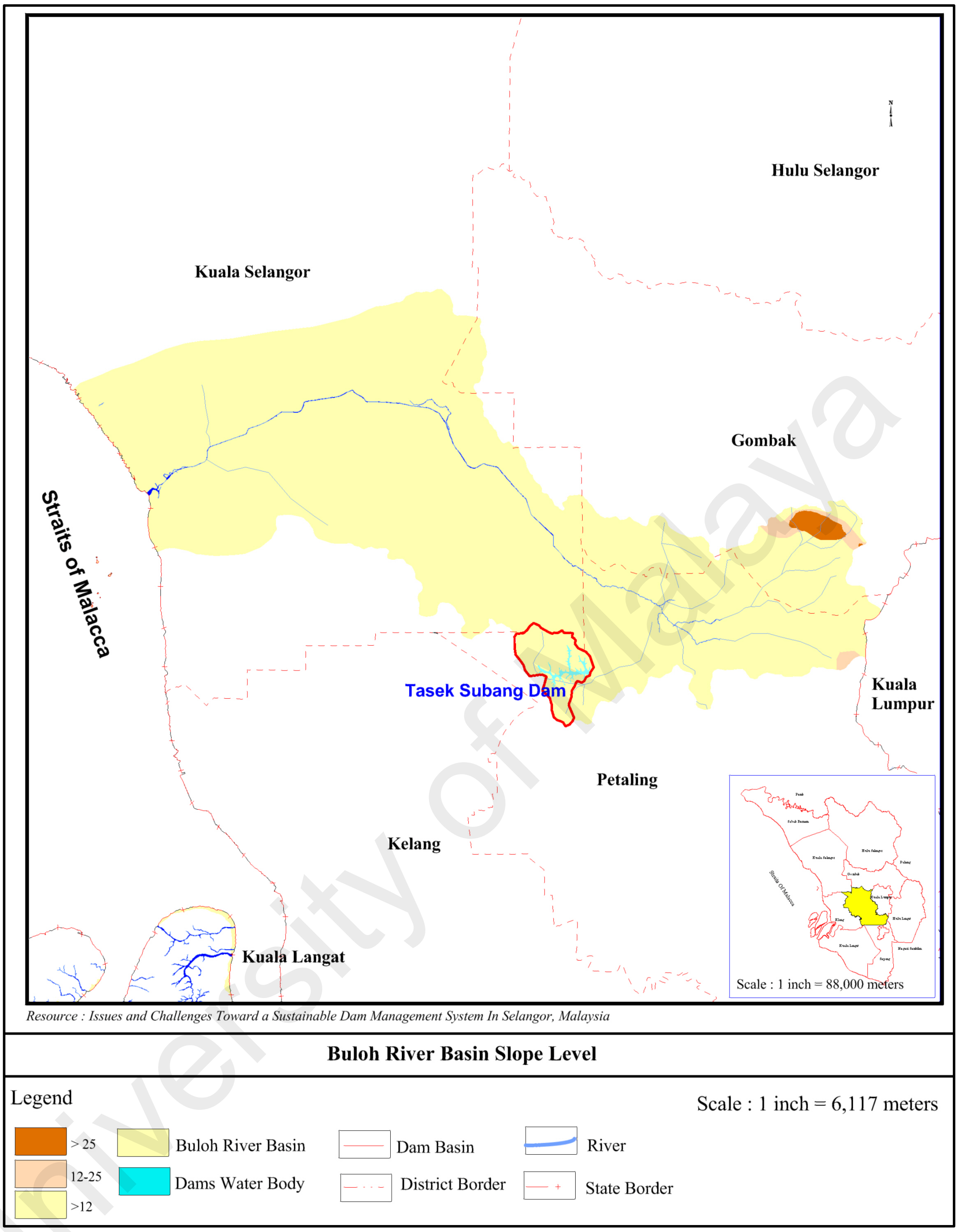


Figure 4.36: Buloh River Basin Slope Level

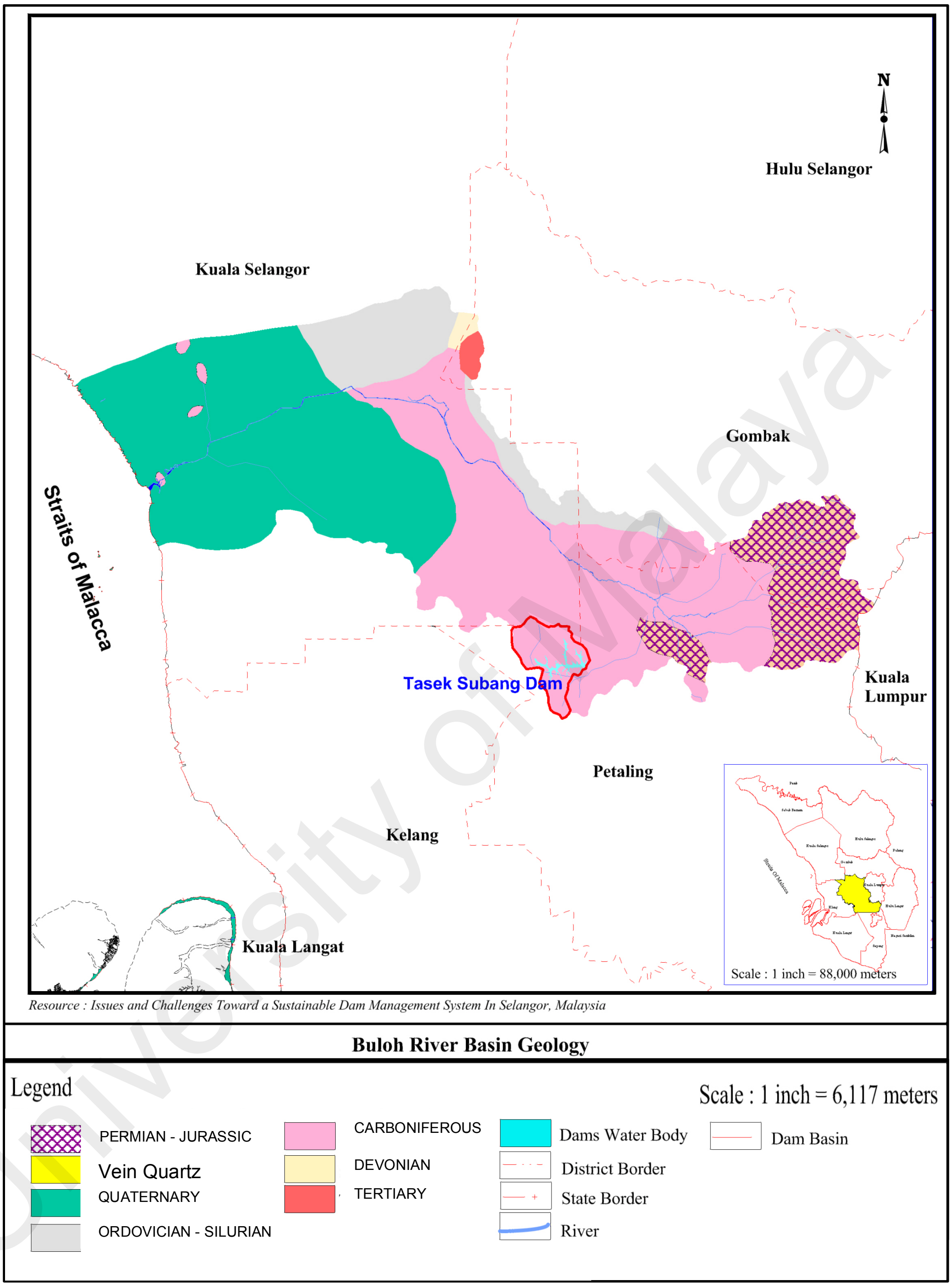


Figure 4.37: Buloh River Basin Geology

4.3.4.3 Land Use

Upper and middle catchment are developed with and housing, industry and institution. Upper catchment area is a Sungai Buloh industrial area and the housing area of Bukit Subang. Middle catchment area is Puncal Alam City, UiTM Puncak Alam Campus and the Tasek Subang Dam location. Lower catchment is an agricultural area of the Meru, Kapar and Klang. See figure 4.38.

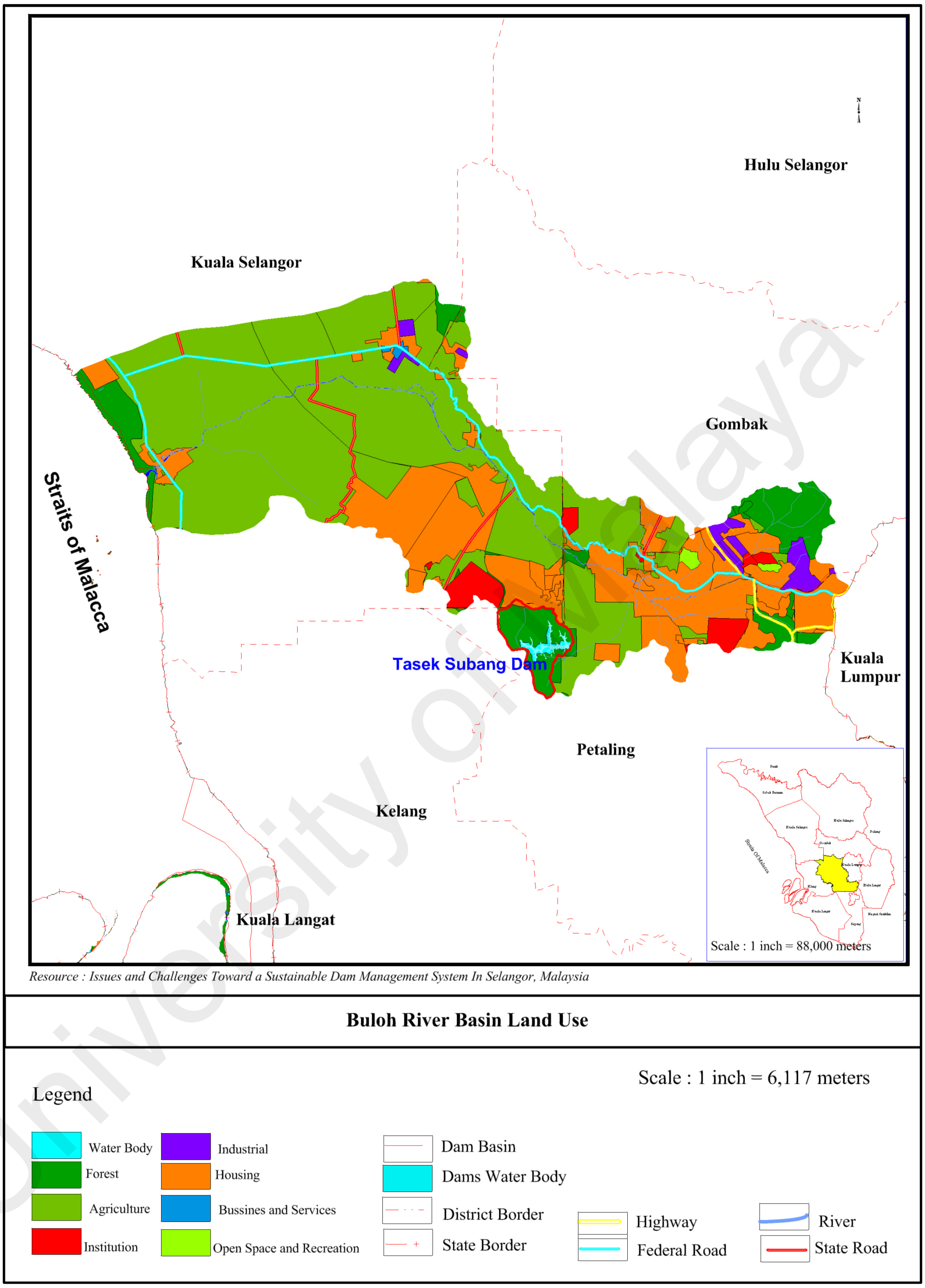


Figure 4.38: Buloh River Basin Land Use

4.3.4.4 Hydrology and Meteorology

*(a) **Buloh River Basin Ground Water Capacity***

Upper catchment area has a ground water capacity below 2500 gallons per hour / well. Middle catchment has the capability between 2500 to 4000 gallon per hour / well. Mean while the lower catchment area has a ground water capacity between 4000 to 6000 gallon per hour / well and above. See Figure 4.39.

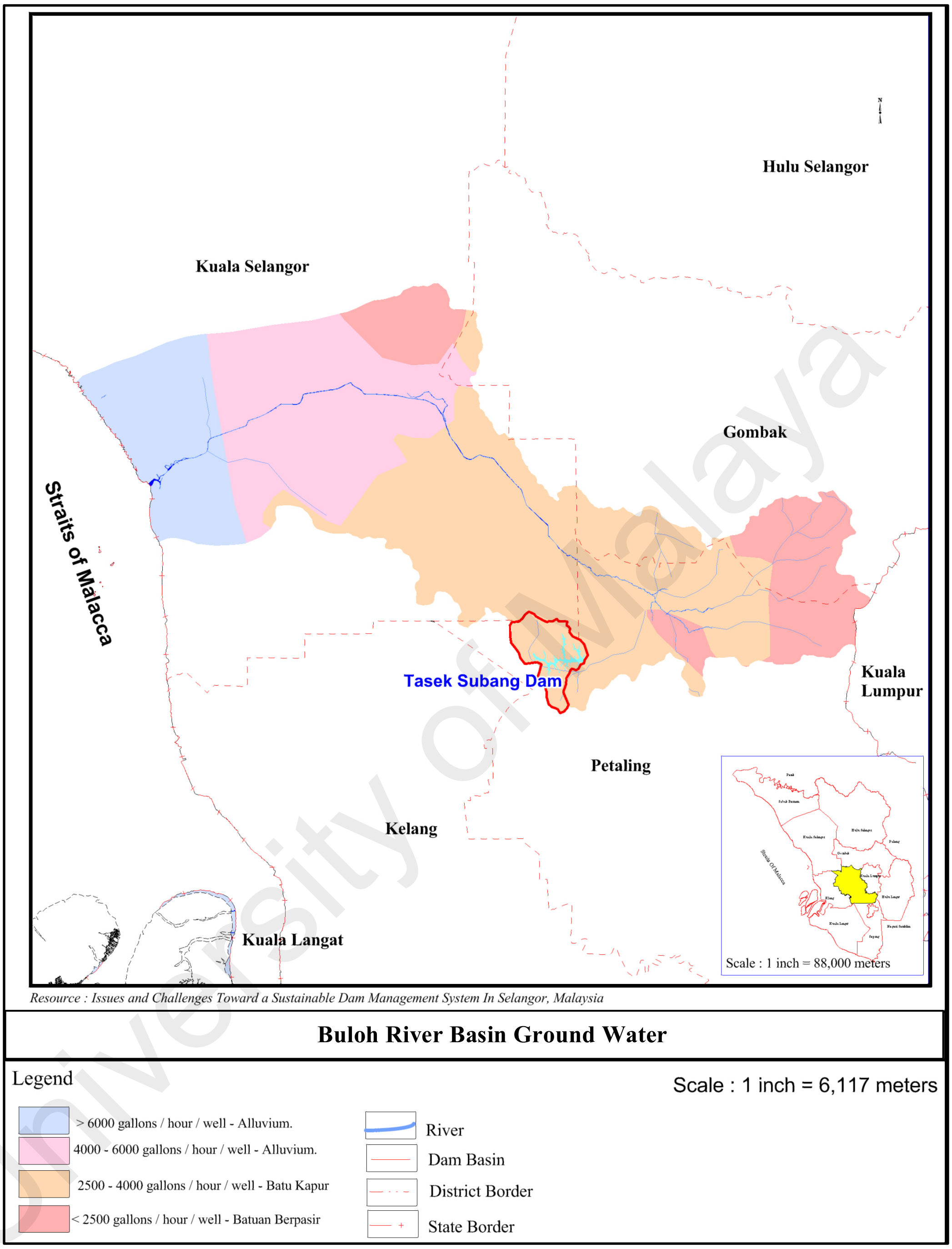
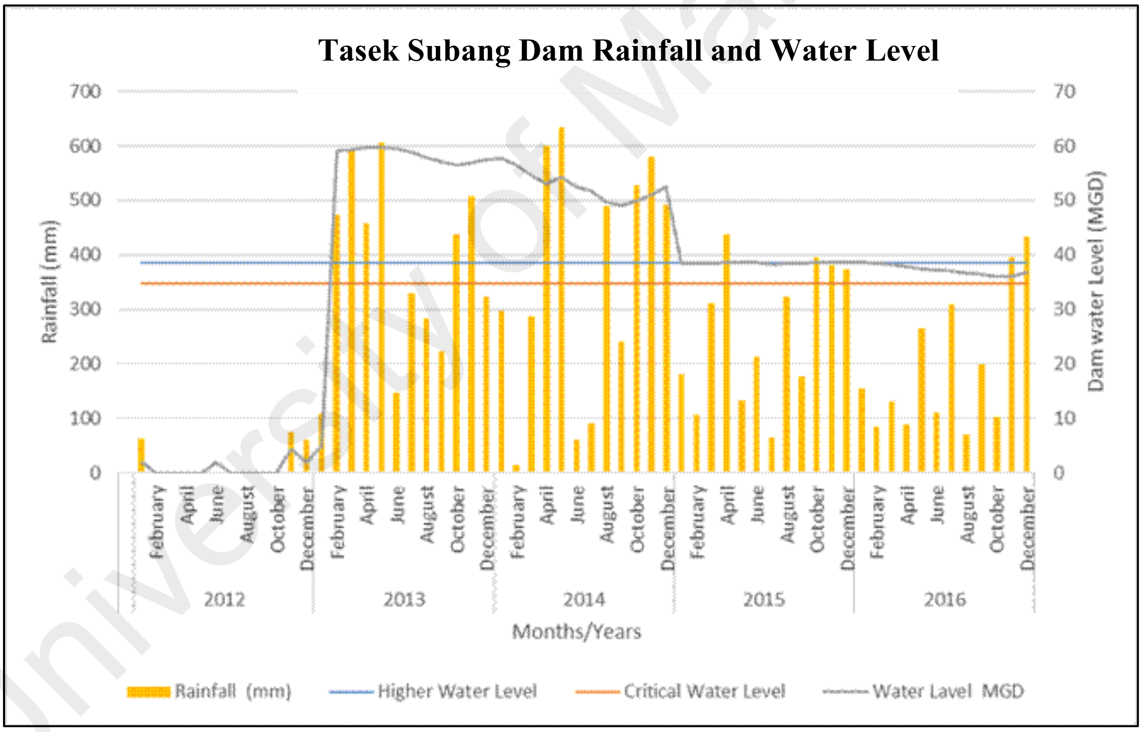


Figure 4.39: Buloh River Basin Ground Water

(b) *Tasek Subang Dam Meteorology*

Tasek Subang Dam Rainfall and Water Level Year 2012 – 2016 are shown on figure 4.40. The water level of the dam is in line with the rate of rainfall. Overall, there is an increase in rainfall during the northeastern monsoon for 2013 to 2016 started november and start decrease by Mac. High rainfall rates also occur during dry seasons, southwest monsoon between April to Jun for years 2013 and 2014. Whereas for 2015 and 2016 show a reduced rainfall during dry season or southwest monsoon.However, in general the dam water level is still above the critical level.

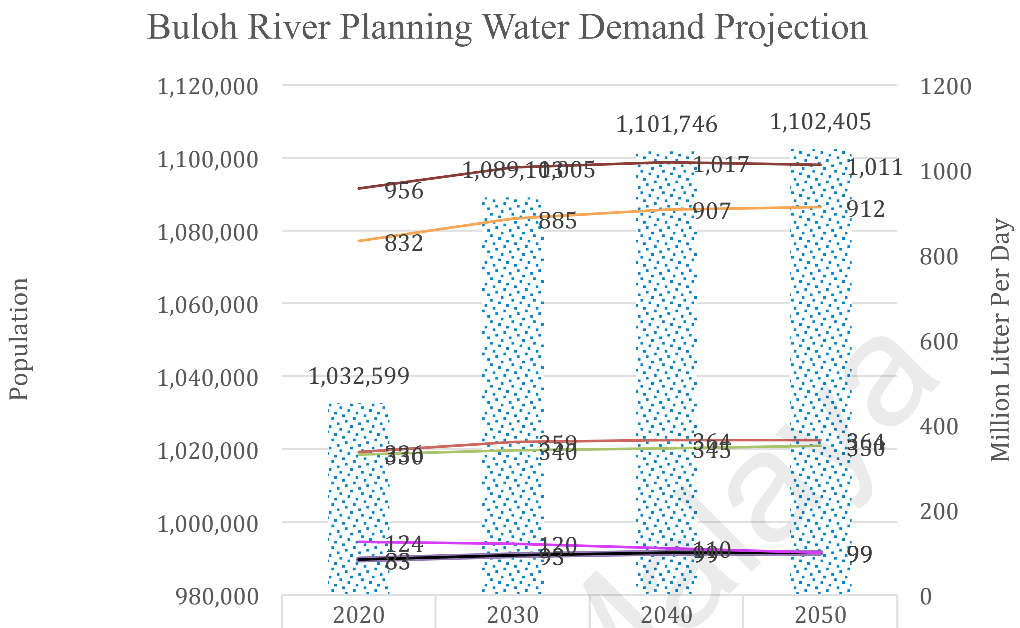


Resource : Selangor Water Management Authority

Figure 4.40: Tasek Subang Dam Rainfall and Water Level years 2012 to 2016

4.3.4.5 Population Served and Water Demand

The Figure shows the projection of population served and water demand for the Buloh River for 2020 to 2050. This projection is covers the area of Kuala Lumpur, Petaling dan Gombak. Figure 4.41 shows the increasing in the number of populations served between 2020 and 2050. Population served are increases from 1,032,599 to 1,102,405. The overall water demand projection is in line with population served growth. Figure, also shows the highest water demand is from the domestic and industrial uses compare to other uses. Generally all categories of use show an increase in water demand between 2020 and 2050. The amount of water lost are decreased within 2020 to 2050 from 124 MLD to 99 MLD.



	2020	2030	2040	2050
Population Served	1,032,599	1,089,103	1,101,746	1,102,405
Domestic	336	359	364	364
Industrial	330	340	345	350
Commercial	83	93	99	99
Institutional	83	93	99	99
Total Uses	832	885	907	912
Losses	124	120	110	99
Demand	956	1,005	1,017	1,011

Year

Resource : Selangor Water Management Authority

Figure 4.41: Buloh River Population Served and Water Demand

4.4 Conclusion

Most dam is located at the upper catchment of the river basin. The highest area and high slope level, exclude the Tasek Subang Dam. The highest level of high land is between 150 meter to 600 meter, and slope level between 12 to 25 degrees. The upper catchment in all river basins in Selangor mostly are undeveloped area except the Buloh River Basin. Ground water capacity in upper catchment of all river basin in Selangor is below 2500 gallons per hour / well.

Major of the middle catchment of a river basin in Selangor has a relief level below 60 meters and the slope level below 12 degrees. Middle catchment all river basins in Selangor is most developed. And the ground water capacity is between 2500 to 4000 gallon per hour / well.

Most of the river basin is the lower catchment is below 60 meters high and has no slope level more than 12 degrees. The lower catchment also covered by an agricultural land use and ground water capacity is between 4000 to 60000 gallon per hour / well and above.

CHAPTER 5: RESULTS AND INTERPRETATION

5.1 Introduction

This chapter will discuss a result and its interpretation by eight (5) subs topic. 1st is Selangor Dams Characteristic, 2nd The Issues in Selangor Dam Basins, 3rd The Existing Dam Management Systems in Selangor, 4th Toward a Sustainable Dam Management Systems for Selangor, and 5th is a final model to discussed and interpreted all research result.

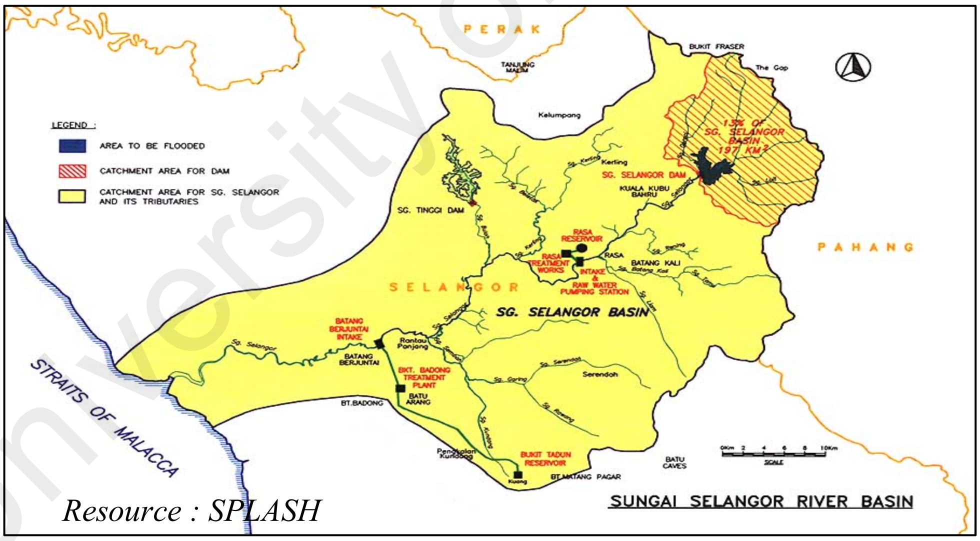
5.2 The Characteristic of Dams in Selangor

5.2.1 The Dams In Selangor

Selangor State have a 7 mains dam surrounded the Klang Valley Development area. There are Sungai Selangor Dam, Sungai Tinggi Dam, Tasek Subang Dam, Batu Dam, Klang Gate Dam, Langat Dam and Semenyih Dam

5.2.1.1 Sungai Selangor Dam

Sungai Selangor Dam, are located at in Kuala Kubu Bharu, Hulu Selangor District, 5km east of Kuala Kubu Bharu at Km 66.5 of Kuala Kubu Bharu – Bukit Fraser Road. Sungai Selangor Dams is a control (regulating dam) that can accommodate a total water capacity of 235 million cubic meters of water with a maximum height of 220 meters. The total capacity of the Sungai Selangor Dam is critical at 30% of a total of 69 million cubic meters of water at an altitude of 184.63 meters. The dam supplies water to be treated in three (3) water treatment plant (WTP), namely; WTP Sungai Selangor Phase 1 (SSP1), LPA Sungai Selangor Phase 2 (SSP2) and mld WTP (SSP3) see (Figure 5.4). Feel LPA and LPA Long Sleeve also receive a supply of treated water to the dam. Dams contribute 60% of water supply in the Klang Valley. The Sungai Selangor dam was constructed on solid granite bedrock just downstream of the confluence of Sungai Selangor and Sungai Lui. It is a rockfill dam with a 110 m high wall that inundates an area of 600 hectares that includes 5km stretch of the road to Fraser's Hill and two Orang Asli settlements namely Kg. Pertak and Kg. Gerachi. The reservoir has a huge maximum storage capacity of 230 million cubic metres and 5 million cubic metres as dead storage. According to SPLASH, Sungai Selangor is under The Sungai Selangor Water Supply Scheme Phase 3 (SSP3) is a project initiated by the Selangor State Government in the wake of the 1998 water crisis which affected people from all walks of life in Selangor and the Federal Territory. Where this scheme are involved 1) A regulating dam which is a Sungai Selangor Dam; 2) Two water treatment plants, each located in Rasa (250 Mld) and Bukit Badong (800Mld); 3) The realignment of Kuala Kubu Bharu-Bukit Fraser Road; 4) Relocation of Institut Kemahiran Belia Negara (IKBN) and 5) Relocation of 2 Orang Asli villages comprising 84 families, see (figure : 5.1 and 5.2) and the detail information about the Sungai Selangor Dam see (Table 5.1).



Resource : SPLASH

Figure 5.1: Sungai Selangor Dam Water Treatment Plant Location

Table 5.1: Sungai Selangor Dam Detail Information

Size Category		Large
Year Built		2001
Location		Kuala Kubu Baru, Hulu Selangor
Dam Structure	Type	Earth - Core Rockfill
	Elevation (m)	110
	Level Peak (m)	800
	Long Peak (m)	227
Dam Reservoir	Water Catchment Area (sq.km)	19.7
	Capacity (mcm)	235
	Maximum spillway discharges (cumecs)	3000
	Surface Area (sq.km)	6
	Ordinary Level (NPL in m)	220
Disaster Class		High - those where failure or mis-operation will probably cause loss of human life.
Function		Water Resource And Reservoir Control Regulating Dam - A dam impounding a reservoir from which water is released to regulate the flow downstream.
Owner		PUAS
Operator		SPLASH
Area Served		Klang valley, Kuala Selangor, Hulu Selangor.

Figure 5.2: Sungai Selangor Dam Photo

5.2.1.2 Sungai Tinggi Dam

Sungai Tinggi Dam are was located in Hulu Selangor District, Sungai Tinggi Dam (STD) are regulating dams located respectively at the riverheads of Sungai Selangor and Sungai Buloh, major tributaries of Sungai Selangor. This dam serves to control the quantity and water level of Sungai Buloh and Sungai Selangor that supply the water sources to the Rantau Panjang and Bukit Badong Water Treatment Plant, see (figure 5.2). Basic information about Sungai Tinggi Dams see (Table 5.2). Photo of Sungai Tinggi Dam see (figure 5.3)

Figure 5.3: Sungai Tinggi Dam Photo

Table 5.2: Sungai Tinggi Dam Detail Information

Size Category		Large
Year Built		1995
Location		Hulu Selangor
Dam Structure	Type	Earth Dam
	Elevation (m)	57.5
	Level Peak (m)	280
	Long Peak (m)	63
Dam Reservoir	Water Catchment Area (sq.km)	40
	Capacity (mcm)	122.5
	Maximum spillway discharges (cumecs)	1800
	Surface Area (sq.km)	8
	Ordinary Level (NPL in m)	59.5
Disaster Class		Significant - dams where failure or miss-operation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns.
Function		Water Resource And Reservoir Control Regulating Dam - A dam impounding a reservoir from which water is released to regulate the flow downstream.
Owner		PUAS
Operator		SPLASH
Area Served		Klang valley, Kuala Selangor, Hulu Selangor.

5.2.1.3 Tasek Subang Dam

Tasek Subang dam is used to control the quantity of Sungai Subang water levels for North-Hummock Water Treatment Plant in Mukim Bukit Raja. Tasek Subang Dam are located in the administrative area of the Shah Alam City Council Petaling District. Tasek Subang Dam Water Catchment area are bordered by Klang and Kuala Selangor District. The detail information about type and function of the Tasek Subang Dam, see (Table 5.3) and (Figure 5.4).

Table 5.3: Tasek Subang Dam Detail Information

Size Category		Small
Year Built		1950
Location		Shah Alam Selangor
Dam Structure	Type	Earth Embankment
	Elevation (m)	9.1
	Level Peak (m)	123
	Long Peak (m)	38.7
Dam Reservoir	Water Catchment Area (sq.km)	10.16
	Capacity (mcm)	3.5
	Maximum spillway discharges (cumecs)	22
	Surface Area (sq.km)	0.76
	Ordinary Level (NPL in m)	37.87
Disaster Class		High - those where failure or mis-operation will probably cause loss of human life.
Function		Water Supply
Owner		PUAS
Operator		Puncak Niaga Holding Bhd.
Area Served		Kapar And Meru

Figure 5.4: Tasek Subang Dam Photo

5.2.1.4 Batu Dam

Batu Dam is a the main source of raw water supply. is designed for water supply of 163 million liters of crude a day. This dam serves to control the quantity and water level of Sungai Batu for Sungai Batu Water Intake, which located 1.6 km downstream. Currently, Puncak Niaga is abstracting water direct from the dam for domestic and industrial water supply to some parts of Kuala Lumpur. Detail information and Dam photo see (Table 5.4) and (figure 5.5).

Table 5.4: Batu Dam Detail Information

Size Category		Large
Year Built		1987
Location		Gombak Selangor
Dam Structure	Type	Earth
	Elevation (m)	44.0(L)
	Level Peak (m)	550(L)
	Long Peak (m)	109
Dam Reservoir	Water Catchment Area (sq.km)	50
	Capacity (mcm)	36.6(L)
	Maximum spillway discharges (cumecs)	228
	Surface Area (sq.km)	2.5
	Ordinary Level (NPL in m)	102.7
Disaster Class		High - those where failure or mis-operation will probably cause loss of human life.
Function		Water Supply And Flood Mitigation
Owner		Department Of Irrigation And Drainage Malaysia
Operator		Department Of Irrigation And Drainage Malaysia
Area Served		Gombak

Resources : Field Study & Data Collection 5 October 2012

Figure 5.5: Batu Dam Photo

5.2.1.5 Klang Gate Dam

Klang Gate dam serves to control the quantity and level of Sungai Klang for water intake in Bukit Nenas Water Treatment Plant. Dam Reservoir are located in two are of different local government namely Ampang Jaya and Selayang Municipalities. Detail information and dam photo see (Table 5.5) and (Figure 5.6).

Table 5.5: Klang Gate Dam Detail Information

Size Category		Large
Year Built		1959
Location		Gombak Selangor
Dam Structure	Type	Concrete – Reinforced Concrete Dam
	Elevation (m)	36.8 9
	Level Peak (m)	138.7
	Long Peak (m)	97.9
Dam Reservoir	Water Catchment Area (sq.km)	77.16
	Capacity (mcm)	32.02
	Maximum spillway discharges (cumecs)	400
	Surface Area (sq.km)	2.7
	Ordinary Level (NPL in m)	95.22
Disaster Class		High - those where failure or mis-operation will probably cause loss of human life.
Function		Water Supply
Owner		PUAS
Operator		Puncak Niaga Holding – Water Supply and DID – Flood Control
Area Served		Kuala Lumpur

Figure 5.6: Klang Gate Dam Photo

5.2.1.6 Langat Dam

Langat Dam serves to control the quantity and water level of Langat river, for water intake at Sungai Langat, Batu 11 Cheras, Sungai Serai, Sungai Pangson, Sungai Lolo and Bukit Tampoi Water treatment Plant. Langat Dam are capable to supplying raw water at a rate of 367 to 413 million liters per day to the Sungai Langat water treatment plant. Detail information about the Langat Dam and photo see (Table 5.6) and (Figure 5.7)

Table 5.6: Langat Dam Detail Information

Size Category		Large
Year Built		1976
Location		Hulu Langat Selangor
Dam Structure	Type	Earth - Embankment
	Elevation (m)	61
	Level Peak (m)	366
	Long Peak (m)	224
Dam Reservoir	Water Catchment Area (sq.km)	41.44
	Capacity (mcm)	38.42
	Maximum spillway discharges (cumecs)	550
	Surface Area (sq.km)	2.5
	Ordinary Level (NPL in m)	221
Disaster Class		High - those where failure or mis-operation will probably cause loss of human life.
Function		Water Supply
Owner		PUAS
Operator		Puncak Niaga Holding
Area Served		Hulu Langat, Cheras

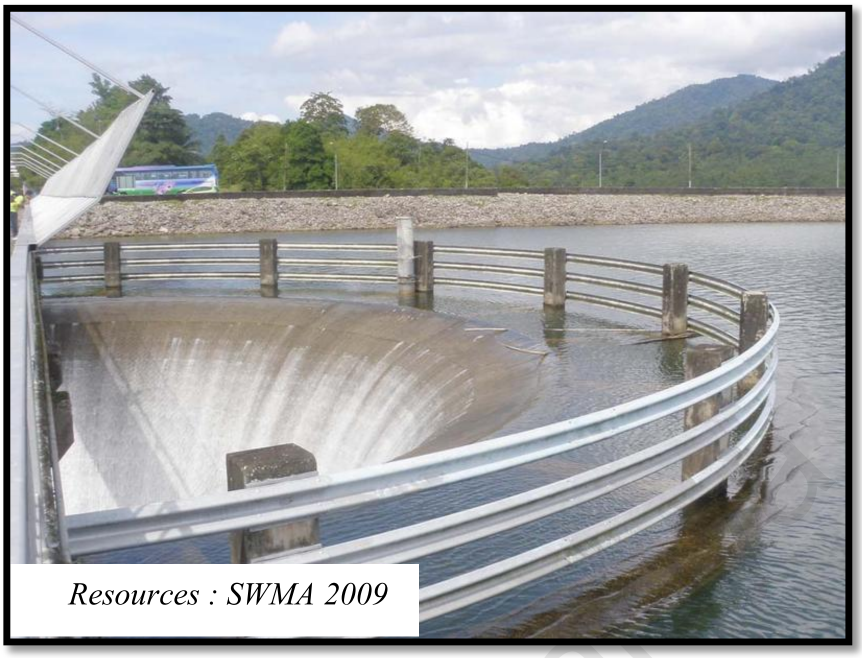


Figure 5.7: Langat Dam Photo.

5.2.1.7 Semenyih Dam

Semenyih Dam serves to control the quantity and water level of Semenyih river, for Jenderam Hilir water intake for Sungai Semenyih Water Treatment Plant at Dengkil. Raw water can be supplied by this dam to Sungai Semenyih Water Treatment Plant is 545 million liters per day. Semenyih Dam is under The Sungai Semenyih Water Supply Scheme implemented by the Selangor State Government supplies clean water to South-West of Kuala Lumpur, Petaling Jaya, Shah Alam, Klang, Putrajaya, Cyberjaya, Sepang, Puchong, Seri Kembangan, Bandar Baru Bangi, Kuala Langat and the surrounding areas. Components of the Scheme are include Semenyih Dam in Hulu Semenyih, Intake Sump and Raw Water Pumping Station in Jenderam Hilir, Water Treatment Plant in Precint 19, Putrajaya, Lake Water Transfer Scheme (WT1) in Jenderam, Semenyih Dam Water Transfer Scheme (WT2) in Hulu Semenyih. Detail information about Semenyih Dam see (Table 5.7) and (Figure 5.8).

Table 5.7: Semenyih Dam Detail Information

Size Category		Large
Year Built		1982
Location		Semenyih Selangor
Dam Structure	Type	Earth
	Elevation (m)	49
	Level Peak (m)	800
	Long Peak (m)	115
Dam Reservoir	Water Catchment Area (sq.km)	56.7
	Capacity (mcm)	61.4
	Maximum spillway discharges (cumecs)	2000 0
	Surface Area (sq.km)	3.6
	Ordinary Level (NPL in m)	111
Disaster Class		High – those where failure or mis-operation will probably cause loss of human life.
Function		Water Supply
Owner		PUAS
Operator		Konsortium ABASS Sdn Bhd
Area Served		Putrajaya, Hulu Langat, Kuala Langat, Sepang, Petaling.

Resources : SWMA 2009

Figure 5.8: Semenyih Dam Photo

5.2.2 The Type, Function, Size And Disaster Class Existing Dam In Selangor

Referred to the table 5.6, from 4 main types of the dam. Selangor State only have two type of dam. One Arch / Concrete Dam, (Klang Gate Dam) and others, six dams is Embankment / Earth Dam. There have no gravity and buttress dam type in State of Selangor. From all categories of dams function, seven main dams in Selangor are functioned as a water supply only. Sungai Selangor Dam and Sungai Tinggi Dam has two function which as water resource supply and reservoir control regulating dam - A dam impounding a reservoir from which water is released to regulate the flow downstream. Batu Dam also have a two function. Other than a water supply, Batu Dam is functioned as a flood mitigation. While Tasek Subang Dam, Klang Gate Dam, Langat Dam and Semenyih Dam are functioned as a water supply dam.There have been to type of size categories of the dam. From seven main dams in Selangor, only one dam is small size categories (Tasek Subang Dam) and others dam is large size categories. On three levels of disaster class, dam in Selangor only has two categories. Only Sungai Tinggi Dam has a significant disaster class level. Others dam disaster class is high. There have been no dam in low disaster class.

Table 5.8: The Type, Function, Size And Disaster Class Existing Dam In Selangor

Dam	Type	Function	Size	Disaster Class
Sungai Tinggi Dam	Embankment	Water supply & reservoir control regulating	Large	Significant
Sungai Selangor Dam	Embankment	Water supply & reservoir control regulating	Large	High
Tasek Subang Dam	Embankment	Water supply	Small	High
Batu Dam	Embankment	Water supply & Flood Mitigation	Large	High
Klang Gate Dam	Ach Dam / Concrete	Water supply	Large	High
Langat Dam	Embankment	Water supply	Large	High
Semenyih Dam	Embankment	Water supply	Large	High

5.3 The Issues In Selangor Dam Basins

5.3.1 The Type Of Activities In Selangor Dam Basins

5.3.1.1 The Type Of Activities In Sungai Selangor Dam Basin

Interference issues, and problems are happened at Sungai Selangor Water Catchment Area are involved several issues. There have two spots of land clearing in the upper site of Sungai Selangor Dam Water Catchment Area. There are likewise have a building structure, which is the aboriginal settlements. And there are also have several spot of angler's pot location. There is a rest area for visitors or members of the public parked in the side of the dam near the main entrance. Where the stop is the transit point for the public from the Fraser Hill and also others from the Hulu Selangor to the Fraser Hill. These locations often face the problem of public attitudes that are not concerned with the preservation of the environment where there is plenty of garbage in the form of discarded food containers in this area. Disruption of ecosystems also happened when African catfish that are completely different ecosystem and aquatic life in Sungai Selangor dam is release by a public. Although activity in the dam area quite a lot but its distribution is broad and far between each other. See figure 5.9 and 5.10.

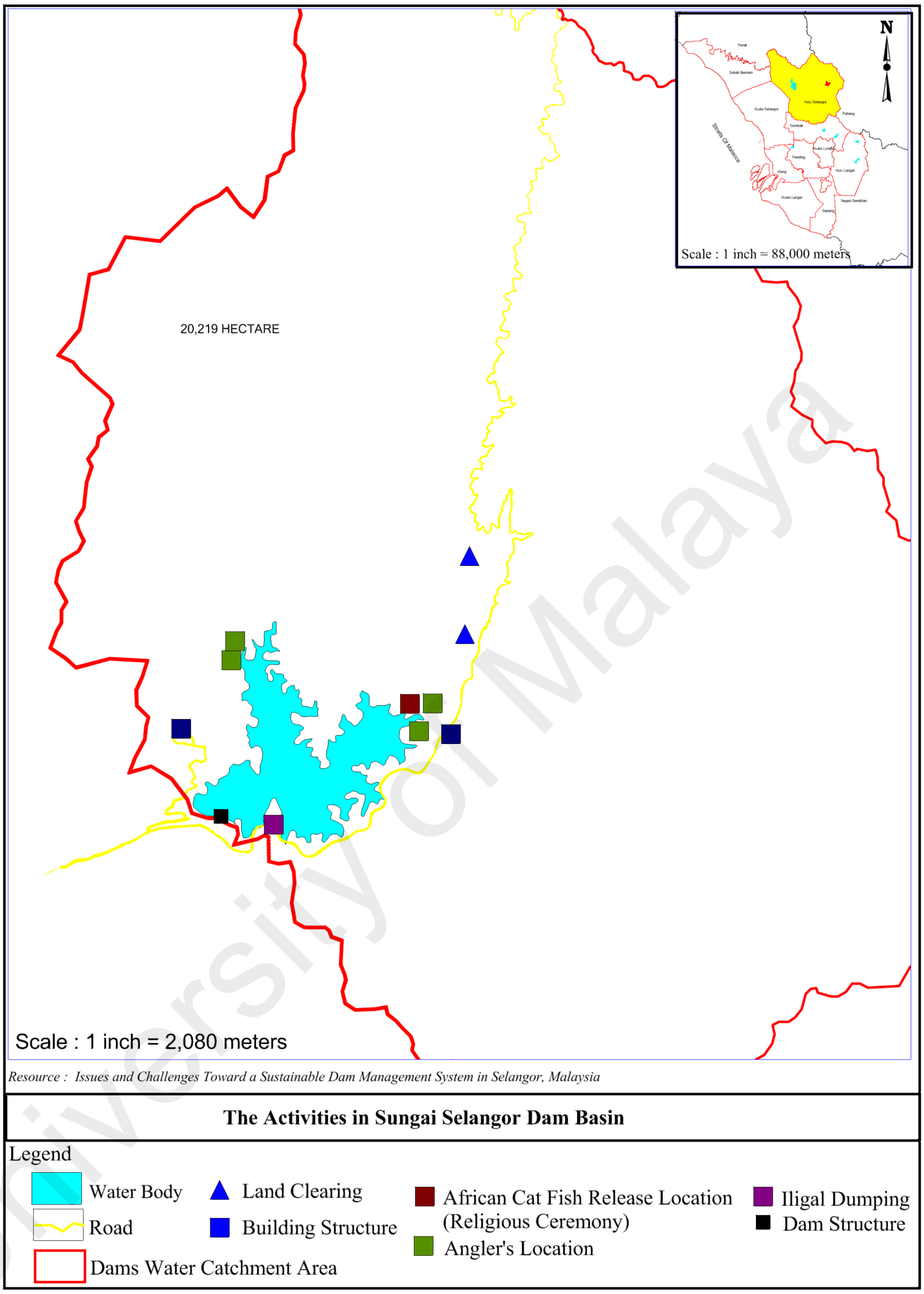


Figure 5.9: The Types Of Activities In Sungai Selangor Dam Basin Map

Resources : Field Study February 2012

Figure 5.10: Dumping Activities at Sungai Selangor Dam Area Photo

Figure 5.14 shows a picture of waste dumped by the public who stop at the Sungai Selangor Dam area. The figure also shows the bins provided by the SPLASH to avoid waste dumped by polluting the water content of the dam. Under these circumstances clearly show still a lack of awareness among the public about the important of the dam conservation.

Resources : SWMA 2009

Figure 5.11: Cat Fish Release Location Photo

Figure 5.11 shows the cat fish release location. As reported by LUAS, there have happened ecological issues incident where there have a happened the African catfish release from the religious ceremony by the public, where they release 50 boxes of African Cat Fish to the Sungai Selangor Dam lake. Which each box has a hundred of African Cat Fish. Part of the fish is not able to adapt to the dam lake water and eventually die. The dead fishes have contributed to the pollution of the lake dam. And some who are still alive will be alien species will monopolize the local river ecosystem is an ecological disaster.

5.3.1.2 The Type Of Activities In Sungai Tinggi Dam Basin

Interference issues and problems that occur at Sungai Tinggi Dam Water Catchment Area are involved, the problems and issues from angler's activities, There have a illegal road or trail are used or explored by anglers it start from the Bandar Baru Lembah Beringin to the Sungai Tinggi Dam water Body see (figure 5.12). Problems are resulting from fishing activities is the waste left behind by anglers and opening to their camping area and also a small path. Base on the figure 5.16 the number of activities in the area of the dam basin is at a low rate. While the distribution is high this indicates a potential for polluted dam basin area is low.

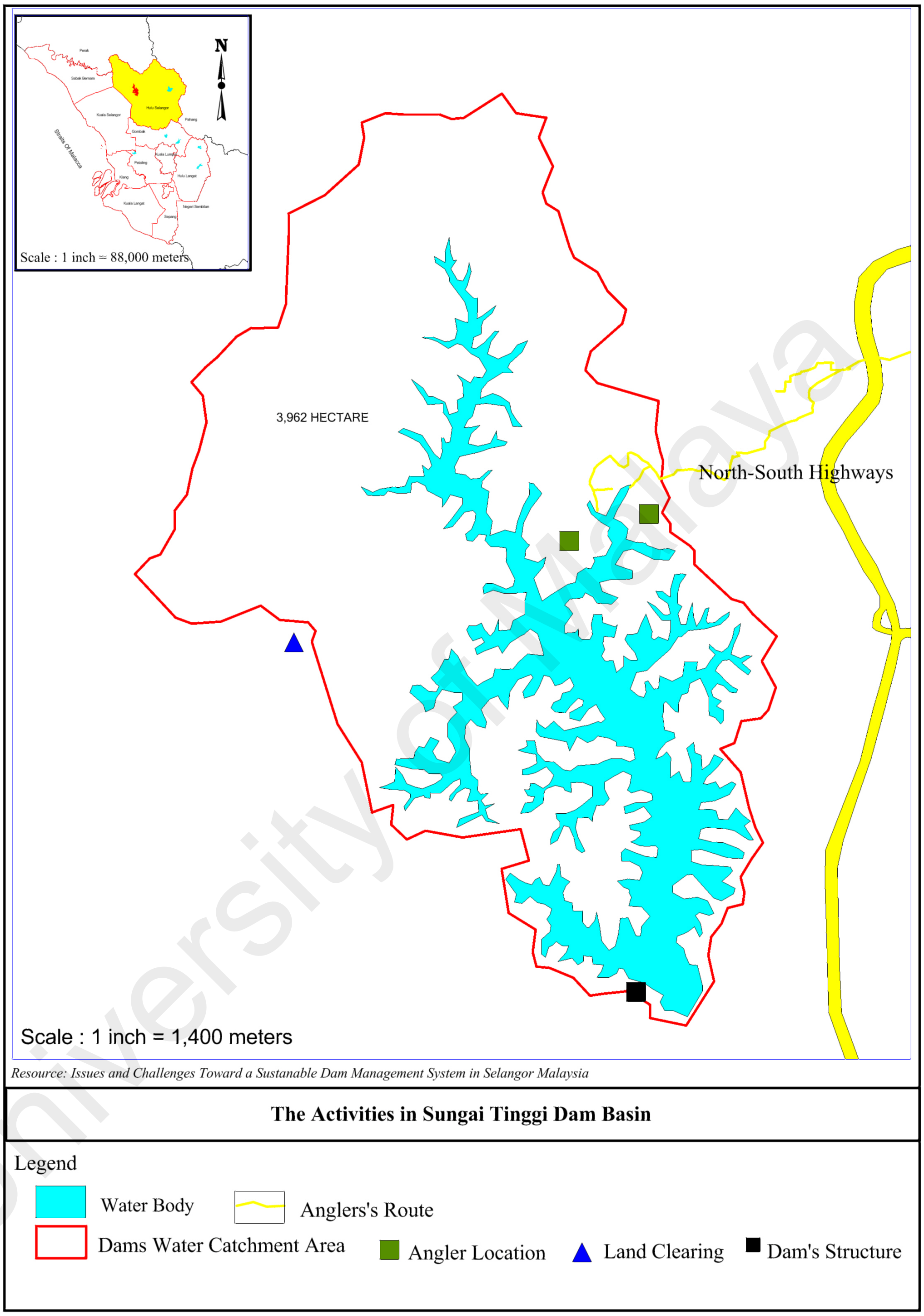


Figure 5.12: The Types Of Activities In Sungai Tinggi Dam Basin Map

5.3.1.3 The Type Of Activities In Tasek Subang Dam Basin.

Although the Tasek Subang Dam are surrounded by urban areas, but, Base on field study there have no human activity in the dam basin. There only has building structure that owned by Puncak Niaga Berhad (Tasek Subang Dam Operator), see (figure 5.13). Since there have no activity make a the activity distribution is a low risk. The main factor or no activity in the dam basin area is, the area are prohibited for the public and there has no public access to the dam water body.

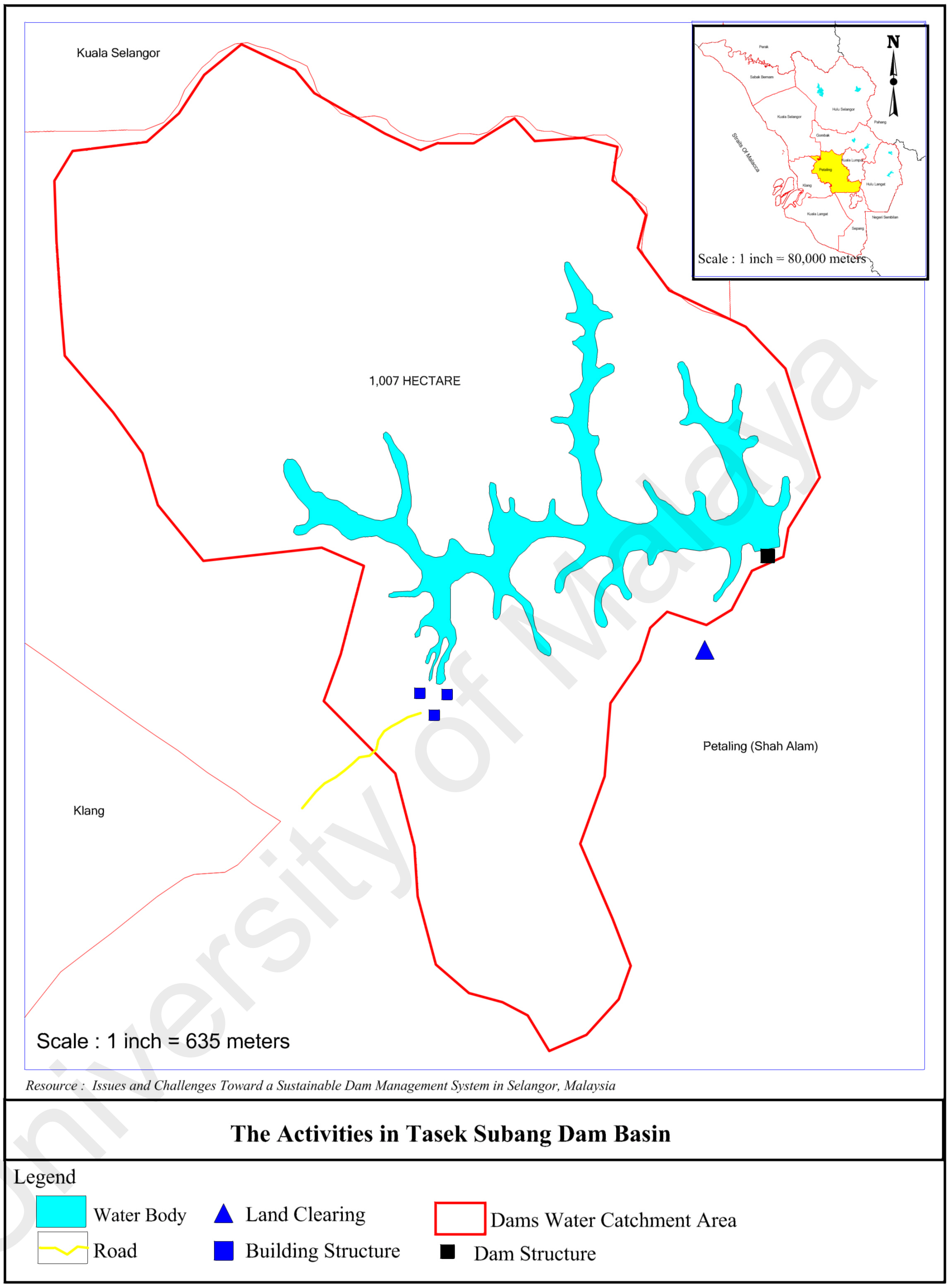


Figure 5.13: The Types Of Activities In Tasek Subang Dam Basin Map

5.3.1.4 The Type Of Activities In Batu Dam Basin

Figure 5.14 shows there have a lot of human activities in the dam basin area. Batu Dam Water Catchment Area has a Sungai Tua public accesses, which it is an alternative road from Kuala Lumpur or Klang Valley to Batang Kali Hulu Selangor. This road is crossed over the Sungai Tua Forest Reserved and the Batu Dam Water Catchment Area. Although, batu Dam area is surrounded by the Forest Reserved, but along the road, there has 16 spot of building structure, two locations of agriculture activities, five spot of land clearing, there also has two location of resort and recreation activities. Batu Dam are also facing the dumping activities, from the bad attitude public and angler. Eventhough the activity is high but the distribution is quite low accept the angler's activities and building.

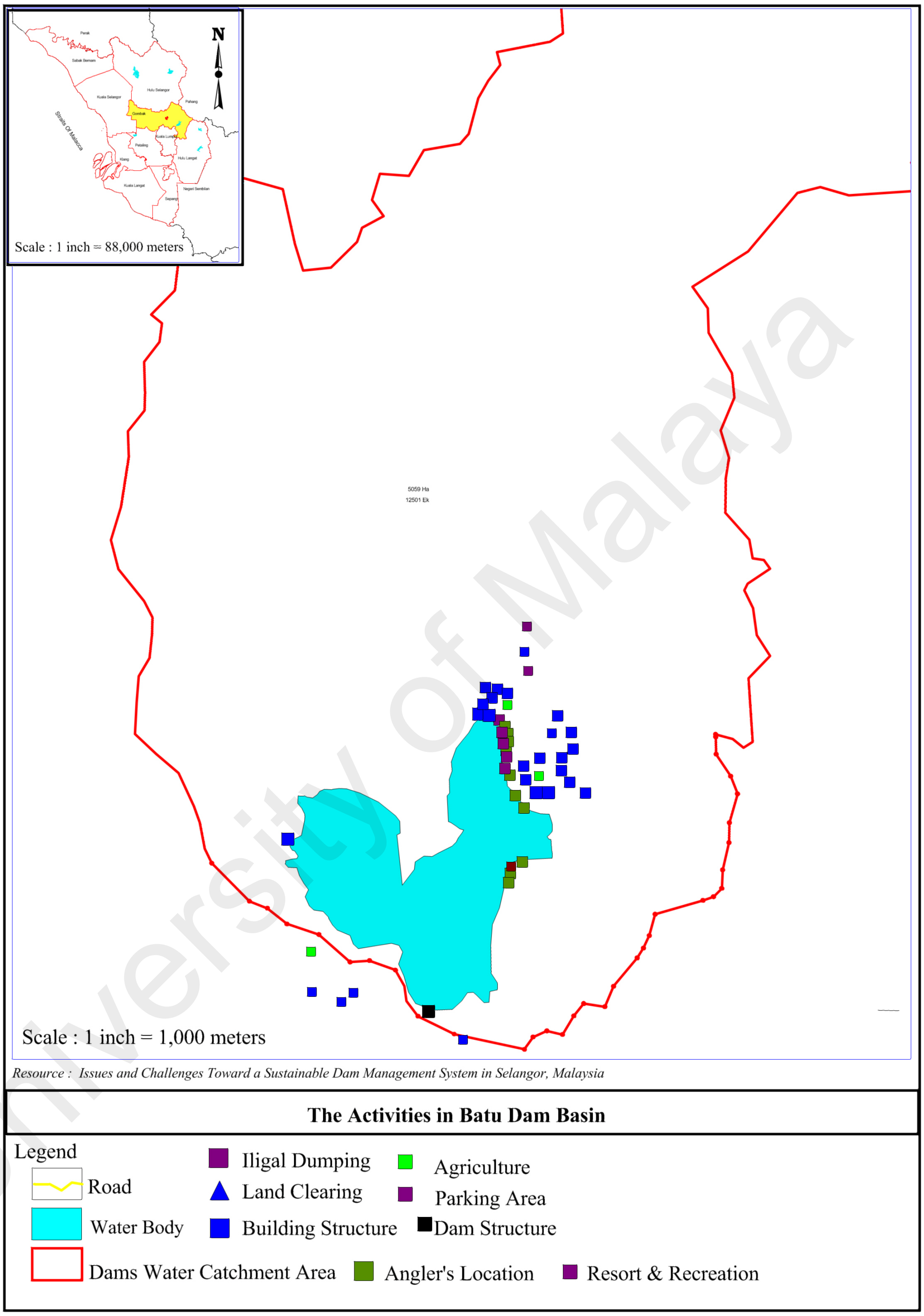
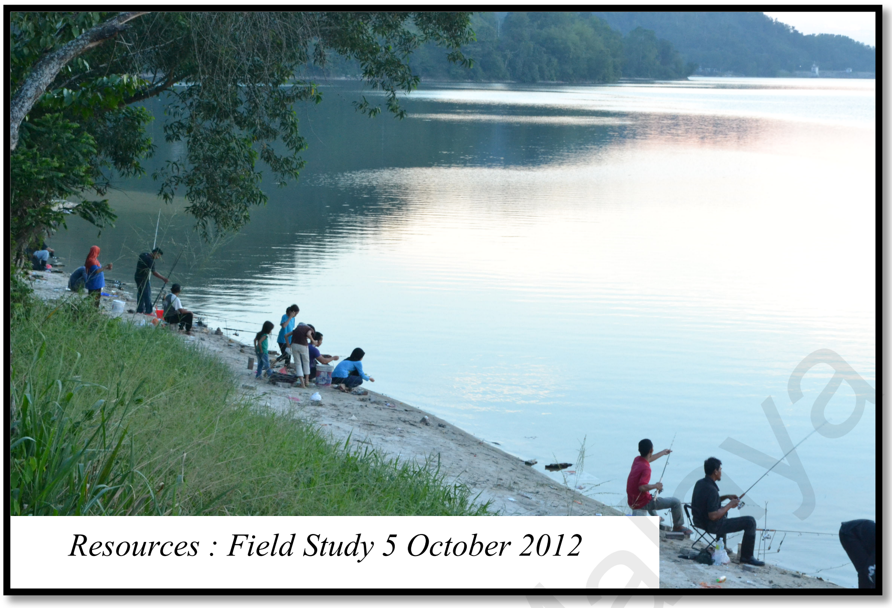


Figure 5.14: The Types Of Activities In Batu Dam Basin Map



Resources : Field Study 5 October 2012

Figure 5.15: Angler at Batu Dam Lake Photo

Base on figure 5.15 the angler are free to enter the dam water body area, they are not only having a fishing activities but in the same time they produces the rubbish and the food that can pollute the surrounding area. Base on the field study, have almost 50 to 60 anglers in this area. The distribution of angler's along the water body area is quite high.


Resources : Field Study 5 October 2012

Figure 5.16: Parking Area and Stall at Batu Dam Lake Photo

Figure 5.16 shows the parking area and the stall at the Batu Dam Area. The figure also shows the public access to the dam area which a Sungai Tua Road. The access and the environment make this area become a recreation area. Almost 50 to 100 visitors will come to this area. There have a lot of activities here such as a camping, fishing, picnic and others.

5.3.1.5 The Type Of Activities In Klang Gate Dam Basin.

Figure 5.17 shows the activities and their distribution in the Klang Gate Dam Basin area. The activities are involves is contradict with the forest. There are areas of illigal angler. Anglers always bring problems of waste disposal in the dam basin area. Rubbish and the oil spill is a main problems related to the angler's. Also there is a small area that was cultivated for farming cash crops such as bananas and other grasses. There are also unauthorized structures are built in the Klang Gate Dam Basin (See Figure 5.17).

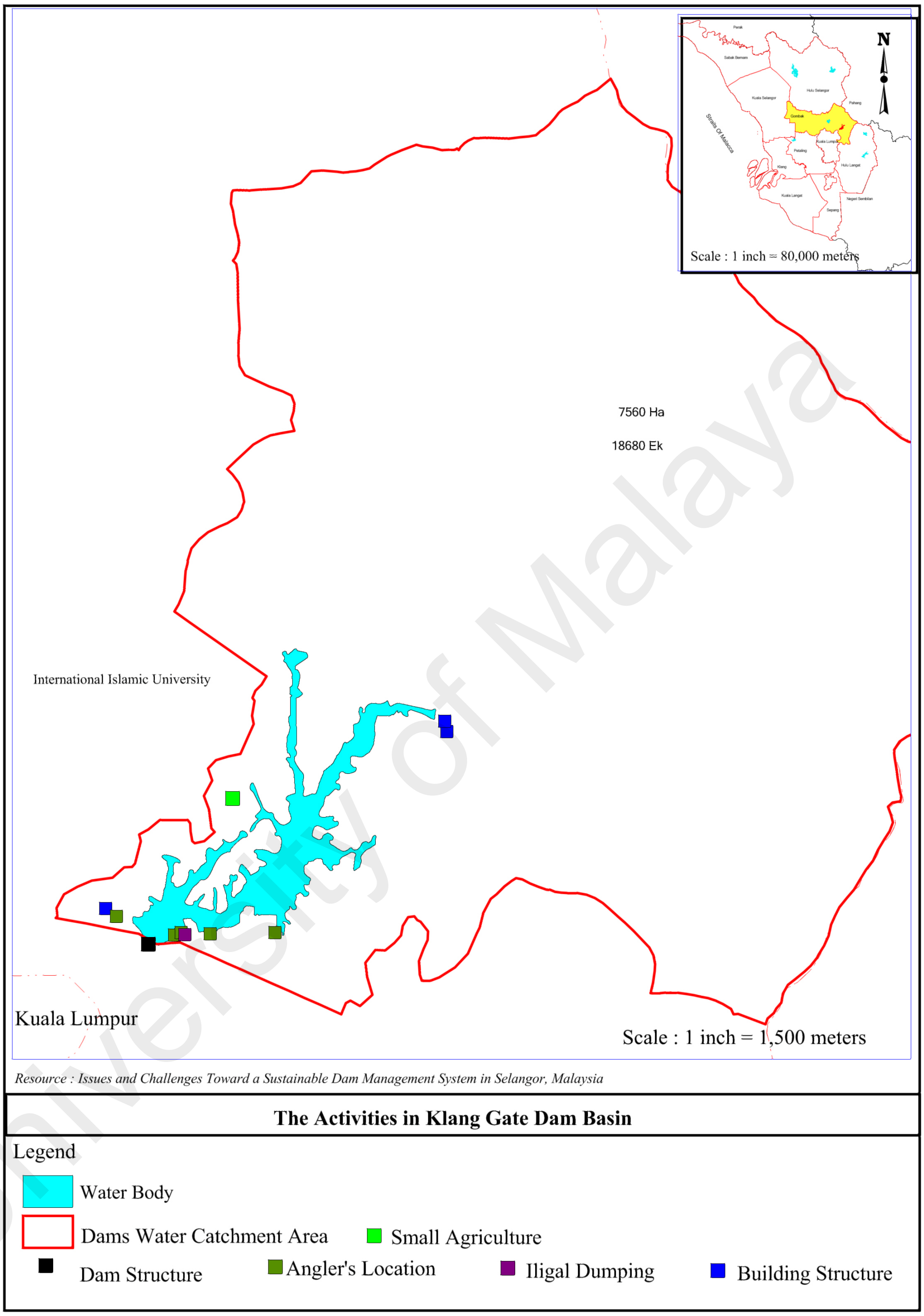


Figure 5.17: The Types Of Activities In Klang Gate Dam Basin Map

5.3.1.6 The Type Of Activities In Langat Dam Basin

Figure 5.18 shows the activity the Langat dam basin. The map shows there have no activity in the dam basin area. There were only structures owned dam operator only. The dam also located away from settlements area. There are also have no public access or roads for the public cross the dam basin area. Public are prohibited to enter the dam basin area. The public access road only allowed up to the main entrance of the dam.

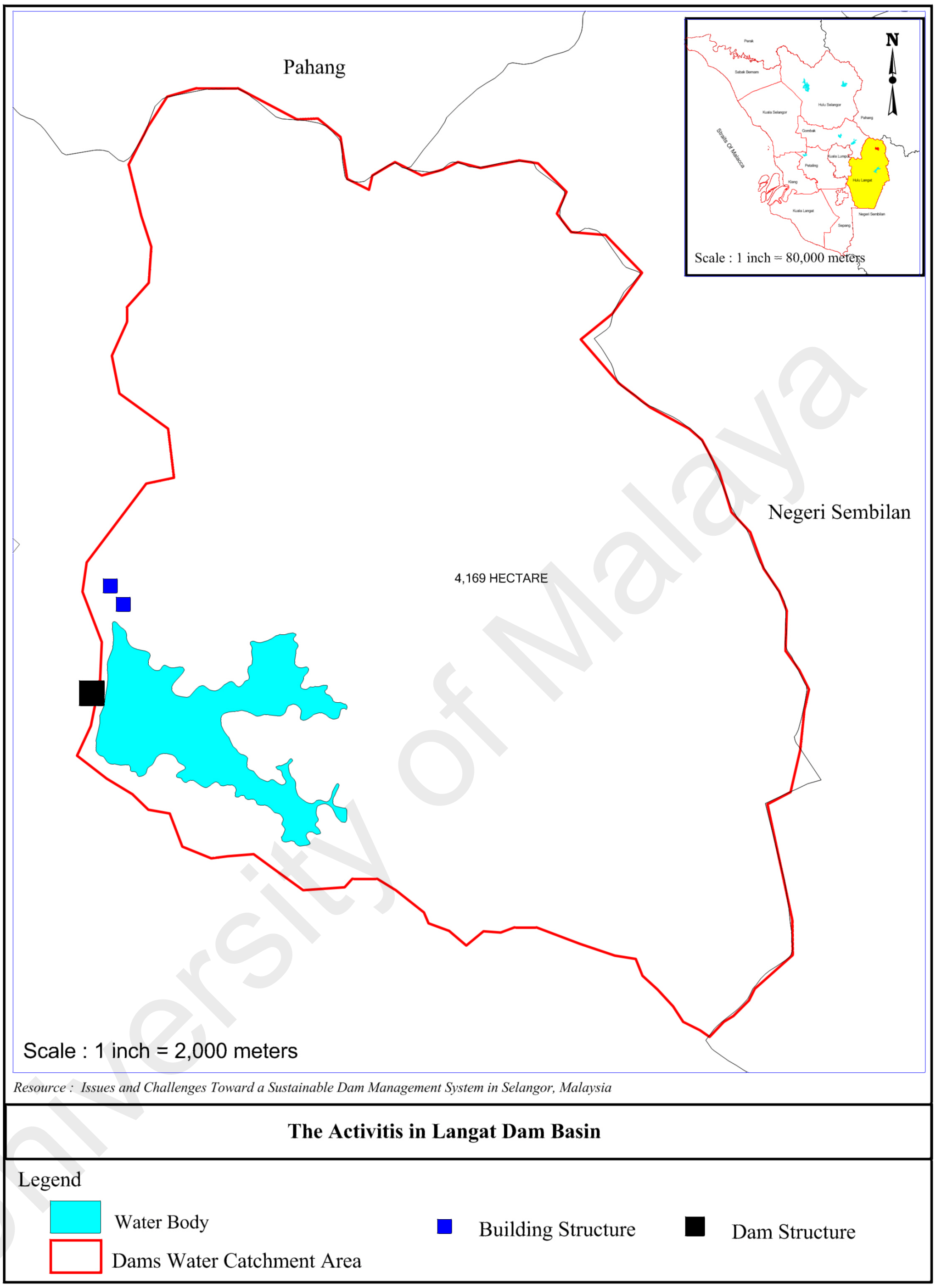


Figure 5.18: The Types Of Activities In Langat Dam Basin Map

5.3.1.7 The Type Of Activities In Semenyih Dam Basin

Figure 5.19 shows the activities in the Semenyih dam Basin area. There have a public access cross the Semenyih Dam Basin area. There have a Sungai Lalang Road and Sungai Tekali Road. Due to the availability of public access, the area is often visited for recreational activities, especially fishing. Field study 15 October 2012 found a dumping site along the road. There also have some small areas of land which flattened for unspecific activity. The telecommunications and TNB sub station are built in the dam basin area. The hill around the dam is equally frequent and prone to slope failure. During the site visit there have a slope failure event. Based on the figure 5.23 clearly shows the Semenyih dam basin is currently having a lot of activities and the threat from human activity. These all activities are supported by the existing public access. With lack of control and enforcement makes the situation is getting worse.

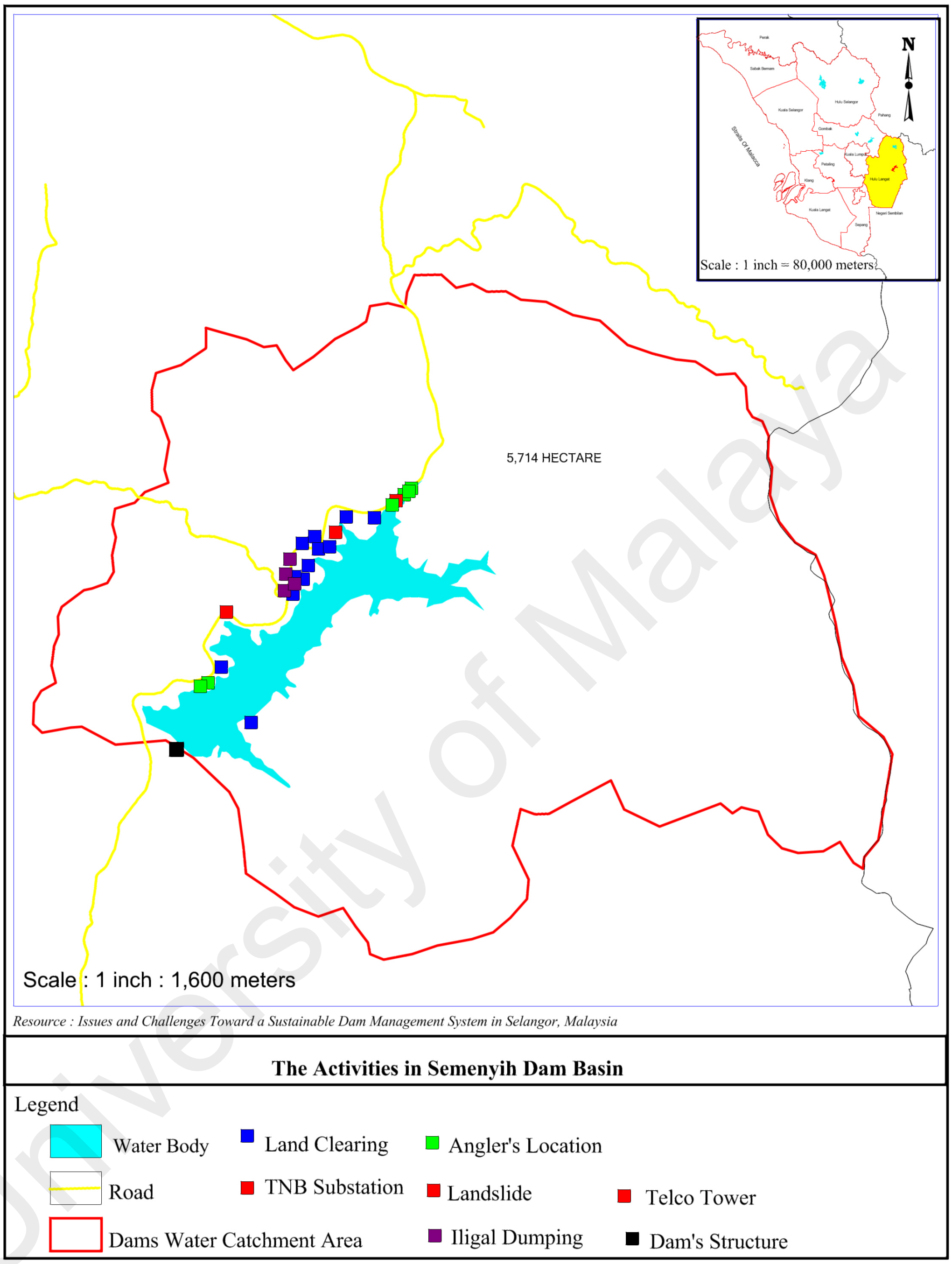


Figure 5.19: The Types Of Activities In Semenyih Dam Basin Map

Resources : Field Study 15 October 2012

Figure 5.20: Illegal Dump Site at Semenyih Dam Area Photo

Figure 5.20 shows the illegal dumpsite along the Sungai Lalang Road and Sungai Tekali Road. This dumpsite location is near to the Semenyih Dam water body. Based on these observations, there are two types of waste dumped in this area. The first type is the most garbage from night market waste and food waste. The second type is the solid waste from the construction site. Based on the waste dumped here, clearly shows the People who throw trash here is the dealer or trader. Their goal is to throw garbage here to reduce business costs. The lowest cost to remove 1 ton of garbage in landfills is RM 50. Traders are not allowed littering in the municipality or the District Council area. Due to road and dam area is quiet and rarely monitored by the authorities, this area to be chosen as the site of dumping by the dealer or trader.

Resources : Field Study 15 October 2012

Figure 5.21: Slope Failure Notice at Semenyih Dam Area Photo

Figure 5.21 shows the slope failure notice at the crossing between Sungai Lalang Road and Sungai Tekali Road. The event is near the dam water body. During this event any vehicles are not allowed to enter the event area especially at the main entrance to the dam structure.

5.3.1.8 Comparative Analysis – The Types Of Activities In Selangor Dam Basins

Built on the table 5.9, out of the seven major dams in Selangor, five dams have interference issues at lower levels. That is, Sungai Tinggi Dam, Klang Gate Dam, Sungai Selangor Dam, Tasek Subang Dam and Semenyih Dam. Langat Dam, have no significant issues of interference. The only dam is facing the interference issues at medium level is Batu Dam.

The severity scale of impact for each activity is divided on to three-point scale. Generally 1 is low; 2 are medium and 3 are high of activities. Parking area and religious ceremony activity is level 1 and considered as a low activity because the parking are not involved any pollution and it's a temporary. It's same with the religious ceremony, which the event just happened once and is temporary impact to the dam basin area. The second level is medium level. The activity in medium level in this study is fishing activity and illegal dumping. The reason why the fishing activity is a medium level is, fishing activity. Fishing activities and illegal dumping reveal the dam area to the problem of oil spills from boats and junk by anglers. Oil spills and garbage will pollute the quality of the dam water. However it is temporary because if this fishing activity can be stopped impacting the dam water catchment area will be temporary. The third level is a high level of interference. The activity in this level is the land clearing, Building structure and resort and recreation activities. Land clearing will reveal dam dams to erosion, thereby contributing to sedimentation in the reservoir. High concentrations of sedimentation will affect the dam structure and will eventually involve safety aspects. Agricultural activity has a huge impact and its effect also involves long periods of time. Agricultural activities involve land clearing, erosion, use of toxins and fertilizers as well as agricultural waste that can pollute the dam water quality. The structure of buildings, resorts and recreation is in the third stage as it has an impact in the long term. It is not only involving land clearing, but also involving domestic disposal that can pollute the quality of the dam water, recreational activities also reveal dam areas to the public. The high number of visitors and the their activity is permanently have a high impact on the dam area.

As a conclusion, from seven major dams in Selangor. Issues and problems happened in dam are in Selangor is more on human causes to the dam area, in form of fishing activities, land clearing, building structure, illegal dumping, parking are, agricultural activities, resort and recreation and others human activities such as religious ceremony. All this activity will harmful the dam area and lead to the degradation impact such as a sedimentation. High sedimentation activities and quantity will give the negative impact to the dam structure and can be led to the dam disaster and flash flood. Four dams in Selangor are facing low level of interference issues, while two dam has no significant interference activities and only one dam at medium level of interference issues.

Table 5.9 : Comparative of Activities in The Dam Basin In Selangor

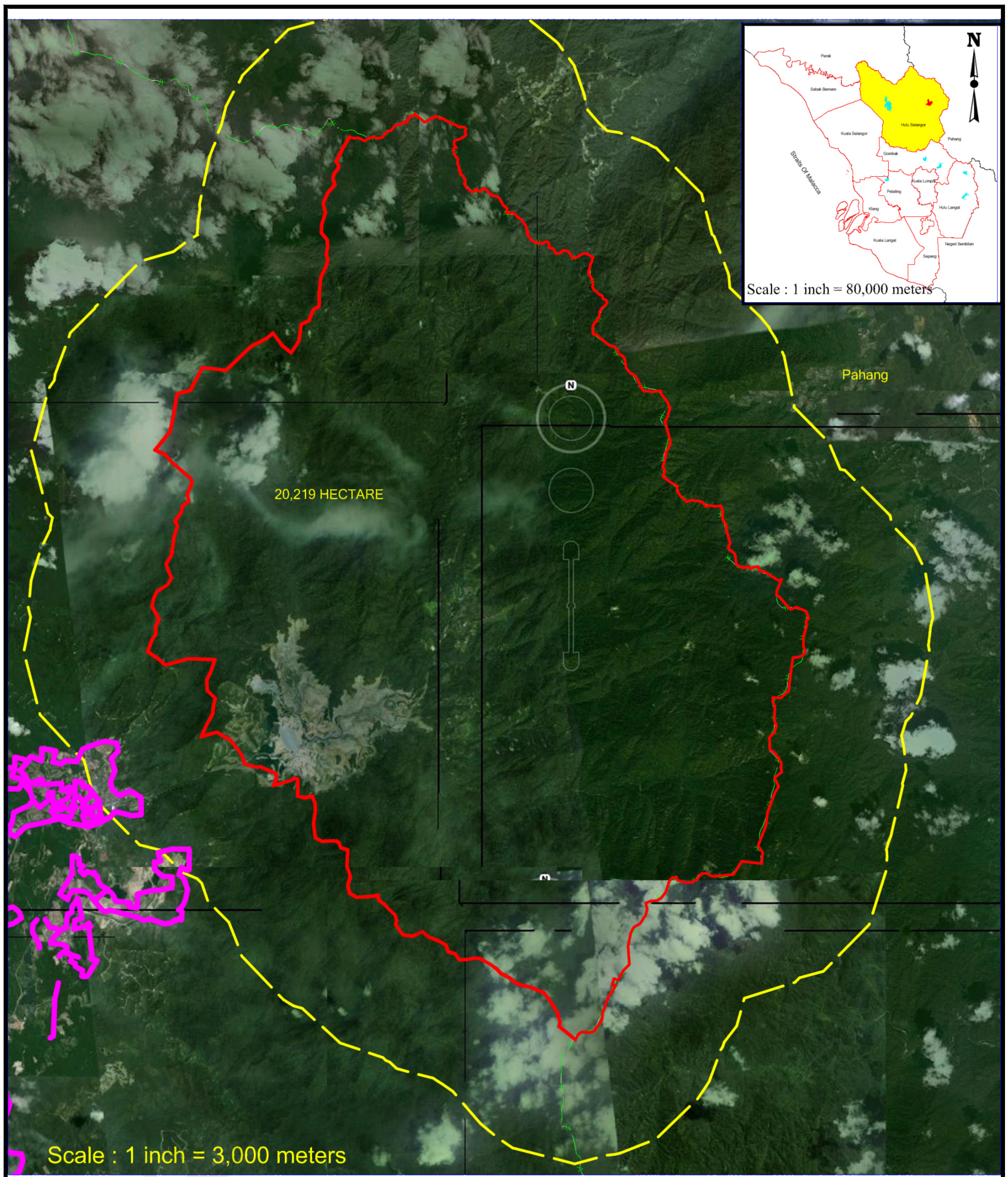
Activity	Dam																				
	Sungai Tinggi			Sungai Selangor			Tasek Subang			Batu			Klang Gate			Langat			Semenyih		
	Total Location	Scale	Score	Total Location	Scale	Score	Total Location	Scale	Score	Total Location	Scale	Score	Total Location	Scale	Score	Total Location	Scale	Score	Total Location	Scale	Score
Fishing	2	2	4	4	2	8	0	2	0	10	2	20	5	2	10	0	2	0	6	2	12
Land Clearing	0	3	0	2	3	6	0	3	0	5	3	15	0	3	0	0	3	0	12	3	36
Building Structure	0	3	0	2	3	6	1	3	3	16	3	48	3	3	9	0	3	0	0	3	0
Religious Ceremony	0	1	0	1	1	1	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0
Illegal Dumping	0	2	0	1	2	2	0	2	0	5	2	10	0	2	0	0	2	0	4	2	8
Parking Area	0	1	0.6	0	1	0	0	1	0	1	1	1	0	1	0	0	1	0	0	1	0
Agriculture Activities	0	3	0	0	3	0	0	3	0	0	3	0	1	3	3	0	3	0	0	3	0
Resort and Recreation	0	3	0	0	3	0	0	3	0	1	3	3	0	3	0	0	3	0	0	3	0
Total	**2**	**-**	**4**	**10**	**-**	**23**	**1**	**-**	**3**	**38**	**-**	**97**	**9**	**-**	**22**	**0**	**-**	**0**	**22**	**0**	**56**
Total Score	**4**			**23**			**3**			**97**			**22**			**0.00**			**56**		
Score Percentage %	**4 / 384 x 100 = 1.04**			**23 / 384 x 100 = 5.99**			**3 / 384 x 100 = 0.78**			**97 / 384 x 100 = 25.26**			**22 / 384 x 100 = 5.73**			**0 / 384 x 100 = 0.00**			**56/ 384 x 100 = 14.6**		
Rank	**Low**			**Low**			**Low**			**Medium**			**Low**			**Not Significant**			**Low**		

5.3.2 The Type of Development Within 3 kilometer Radius From Selangor Dam Basins Border

This section will discuss the Type of Development Within 3 Kilometers radius From Selangor Dam Basins Border. This mapping analysis is to identify whether the dam is surrounding the development, near the development area or far from the development are. All the maps in this section, will explain the development around the dam area within 3 kilometers from the dam basin border. The yellow dashed line is represent the surrounding area within 3 kilometers from the dam basin border and the red line is represented the dam water catchment area (border resource from Selangor Water Management Authority). While, the pink line is representing the built up area

5.3.2.1 The Type of Development Within 3 kilometer Radius From Sungai Selangor Dam Basin Border

Figure 5.22 shows the Type of Development Within 3 Kilometers radius From Sungai Selangor Dam Basin Border. The map shows the development area within a radius of 3 kilometers from the Sungai Selangor Dam basin border. This developed area is a Kuala Kubu Bharu Small Town, which located in the southwest of the dam structure location. Within 3 kilometers from dam basin border in the north, west, north, northeast, east and southeast, is sully covered by forests. The nearest development area is within 2 kilometers from Sungai Selangor Dam Basin Border.



Resource : Issues and Challenges Toward a Sustainable Dam Management System in Selangor, Malaysia

The Type of Developement Within 3 Kilometer Radius from Sungai Selangor Dam Basin Border

Legend

- Buit Up Area
- Dams Water Catchment Area
- Radius 3 km
- District Border
- State Border

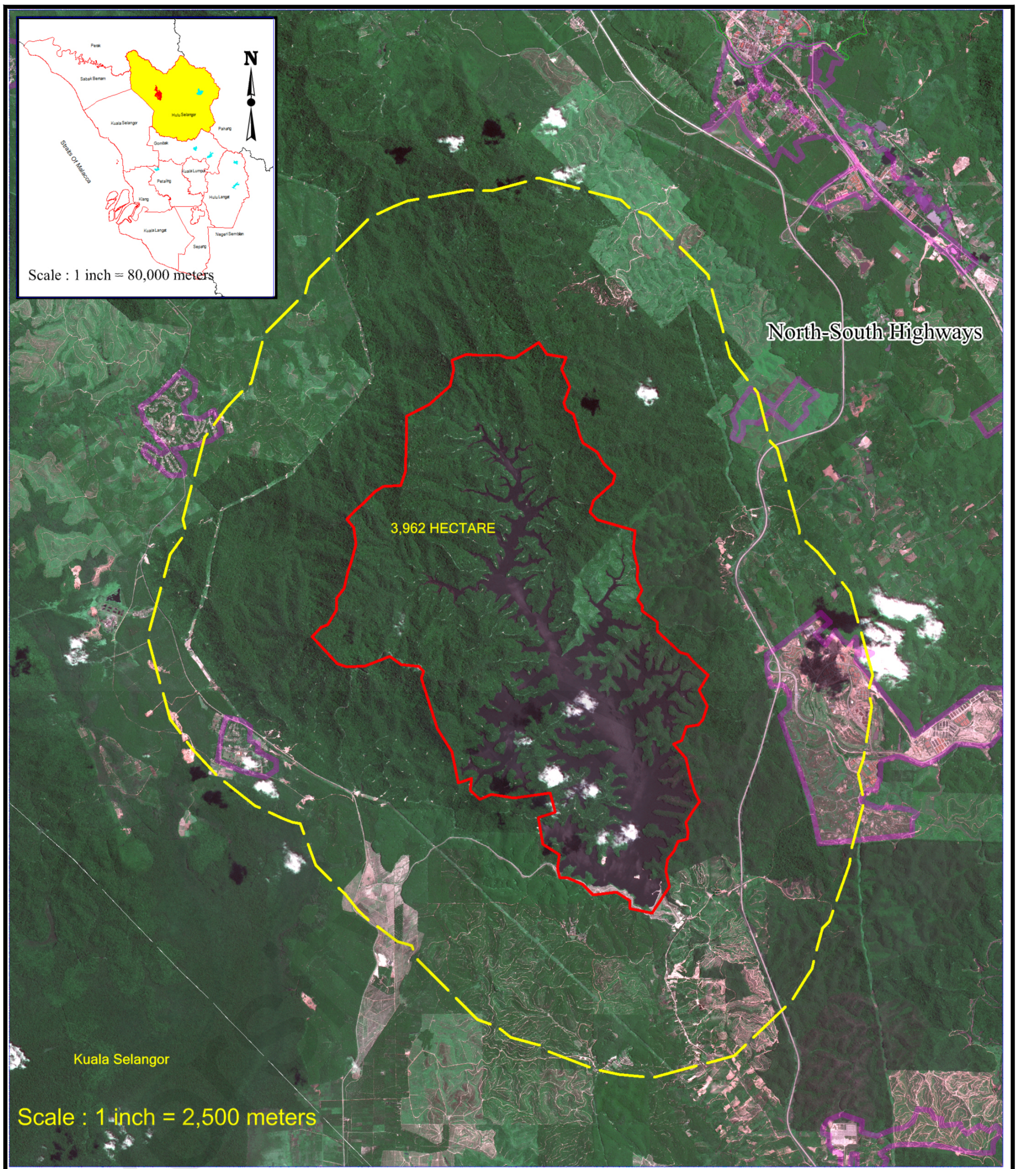
Figure 5.22: The Type of Development Within 3 kilometer Radius From Sungai Selangor Dam Basin Border Map

5.3.2.2 The Type of Development Within 3 kilometer Radius From Sungai Tinggi Dam Basin Border

Sungai Tinggi Dam surrounding development is shown on (Figure 5.23). The maps shown the several development surrounding within three kilometers from the Sungai Tinggi Dam Basin border. On South West, there have a Felda Sungai Tengi, Desa Maju. Meanwhile there have an area of Sungai Tengi and Bandar Baru Lembah Beringin at the west. The Nouth –South Highway is to the east of dam basin border. All the development area surrounding the Sungai Tinggi Dam Basin Border is a new development area in Hulu Selangor accept a Felda Sungai Tengi. The nearest development area is within 1.5 kilometers from Sungai Tinggi Dam Basin border.

5.3.2.3 The Type of Development Within 3 kilometer Radius From Tasek Subang Dam Basin Border

Tasek Subang Dam is the only dam in Selangor are surrounded by the development area (City Area) where on the north there have are new development area on Kuala Selangor which is Bandar Baru Saujana. At the north-west is University Technology Mara (UiTM) Puncak Alam. Meru Town at the South-West. Denai Alam housing area located at the South – East. Alam Budiman, Perdana Height, and Taman Puncak Perdana is located at the south. While the Taman Bukit Subang and Guthrie Corridor Highways at the East see (Figure 5.24). The nearest development area is in the area within 3 kilometers from Tasek Subang Dam Basin border.



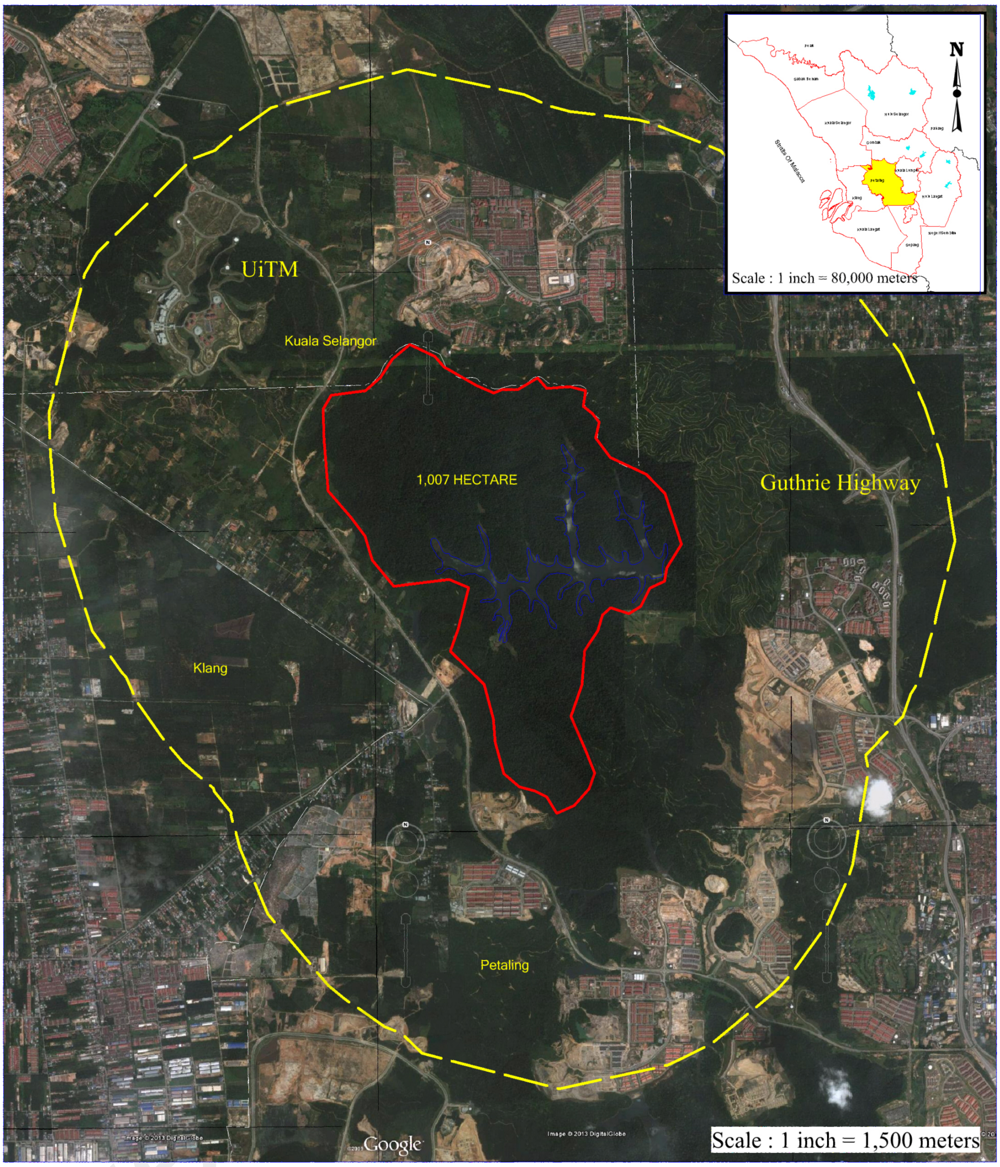
Resource :Issues and Challenges Toward a Sustainable Dam Management System in Selangor, Malaysia

The Type of Development Within 3 Kilometer Radius from Sungai Tinggi Dam Basin Border

Legend

- Buit Up Area
- Dams Water Catchment Area
- Radius 3 km
- District Border
- State Border

Figure 5.23: The Type of Development Within 3 kilometer Radius From Sungai Tinggi Dam Basin Border Map



Resource : Issues and Challenges Toward a Sustainable Dam Management System in Selangor, Malaysia

The Type of Development Within 3 Kilometer Radius from Tasek Subang Dam Basin Border

Legend

3 Km Radius

Water Body

Dams Water Catchment Area

District Border

Figure 5.24: The Type of Development Within 3 kilometer Radius From Tasek Subang Dam Basin Border Map

5.3.2.4 The Type of Development Within 3 kilometer Radius From Batu Dam Basin Border

While Batu Dam area is near to the development area of Selayang and Kuala Lumpur City within 500 meters from the Dam structure. In the within 3 kilometer, from the dam water catchment border on the south they have a width of the development area. It is including the Kuala Lumpur and Bandar Baru selayang development. Were near the Batu Dam structure there have a Taman Jasa Utama, Taman Selayang Mulia, Taman Bukit Permata, Taman Bandar Baru Selayang Phase 2A and 2B, see (Figure 5.25). And to the south, west and east, there has a forest reserve area.

5.3.2.5 The Type of Development Within 3 kilometer Radius From Klang Gate Dam Basin Border

Klang Gate Dam is a second dam that is located too near the urban area, which at the south and at the dam structure there has a housing is within 500 meters from the dam structure it is Taman Desa Malawati. At the north-west there have a Malaysia International Islamic University (UIAM), the Karak Highway in the west and the forest reserve area at the north, east and south case area, see figure 5.26.

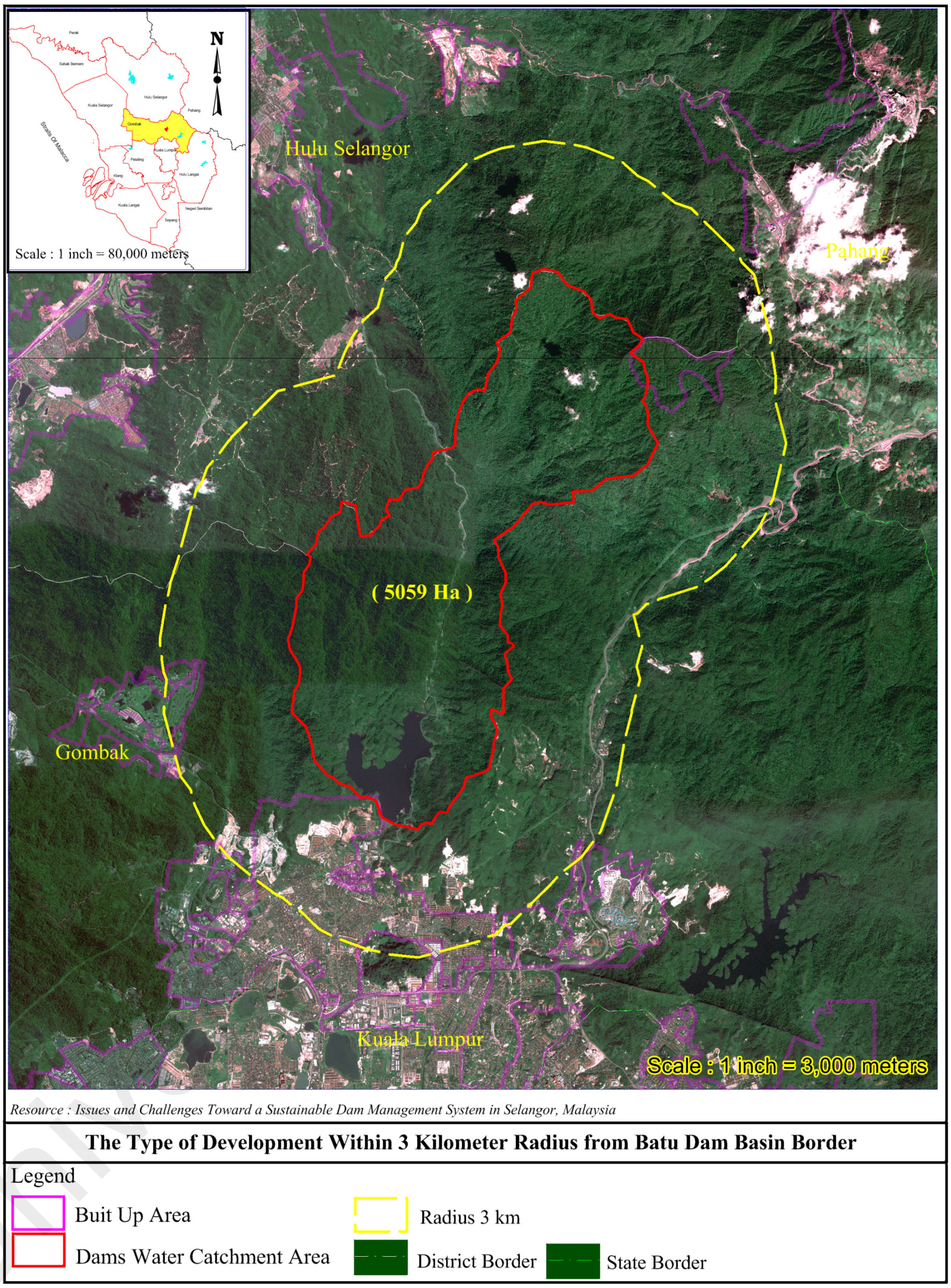
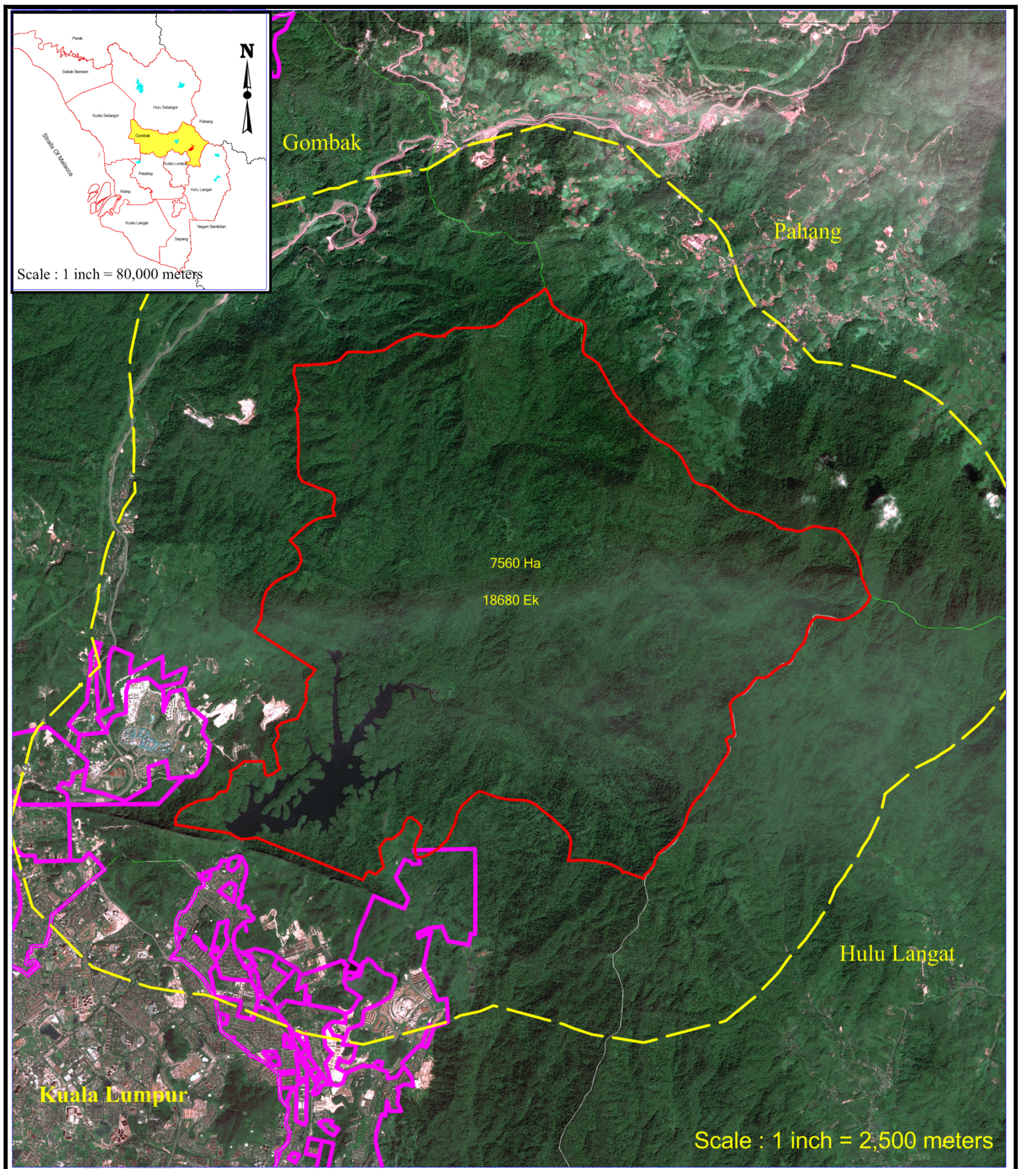


Figure 5.25: The Type of Development Within 3 kilometer Radius From Batu Dam Basin Border Map



Resource : Issues and Challenges Toward a Sustainable Dam Management System in Selangor, Malaysia

The Type of Development Within 3 Kilometer Radius from Klang Gate Dam Basin Border

Legend

Buit Up Area

Dams Water Catchment Area

Radius 3 km

District Border

State Border

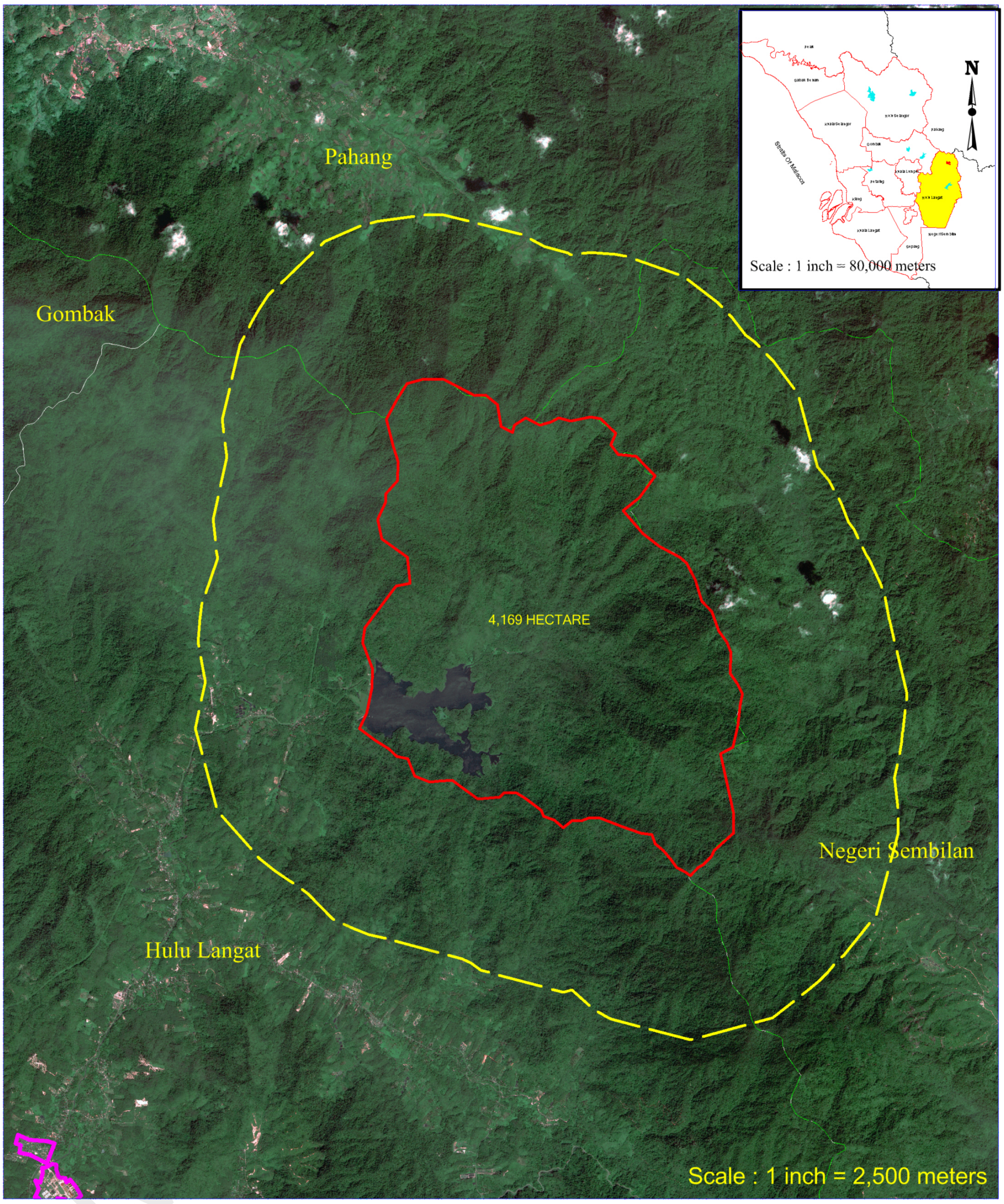
Figure 5.26: The Type of Development Within 3 kilometer Radius From Klang Gate Dam Basin Border Map

5.3.2.6 The Type of Development Within 3 kilometer Radius From Langat Dam Basin Border

Langat Dam area is located far from the urban or development area. Langat Dam Basin is located in Hulu Langat District. Langat Dam Basin area is surrounded by the forest reserve area at the north, east and the south. At the west is located a Kuala Pangson village settlement within 9 kilometers from the Langat dam Structure see (Figure 5.27).

5.3.2.7 The Type of Development Within 3 kilometer Radius From Semenyih Dam Basins Border

Second Dam that is located far away from the urban area is a Semenyih Dam. Semenyih Dam Basin area is fully surrounded by the forest reserve from the north, east, south and west, see figure 5.28.



Resource : Issues and Challenges Toward a Sustainable Dam Management System in Selangor Malaysia

The Type of Development Within 3 Kilometer Radius from Langat Dam Basin Border

Legend

Buit Up Area	Radius 3 km
Dams Water Catchment Area	District Border
	State Border

Figure 5.27: The Type of Development Within 3 kilometer Radius From Langat Dam Basin Border Map

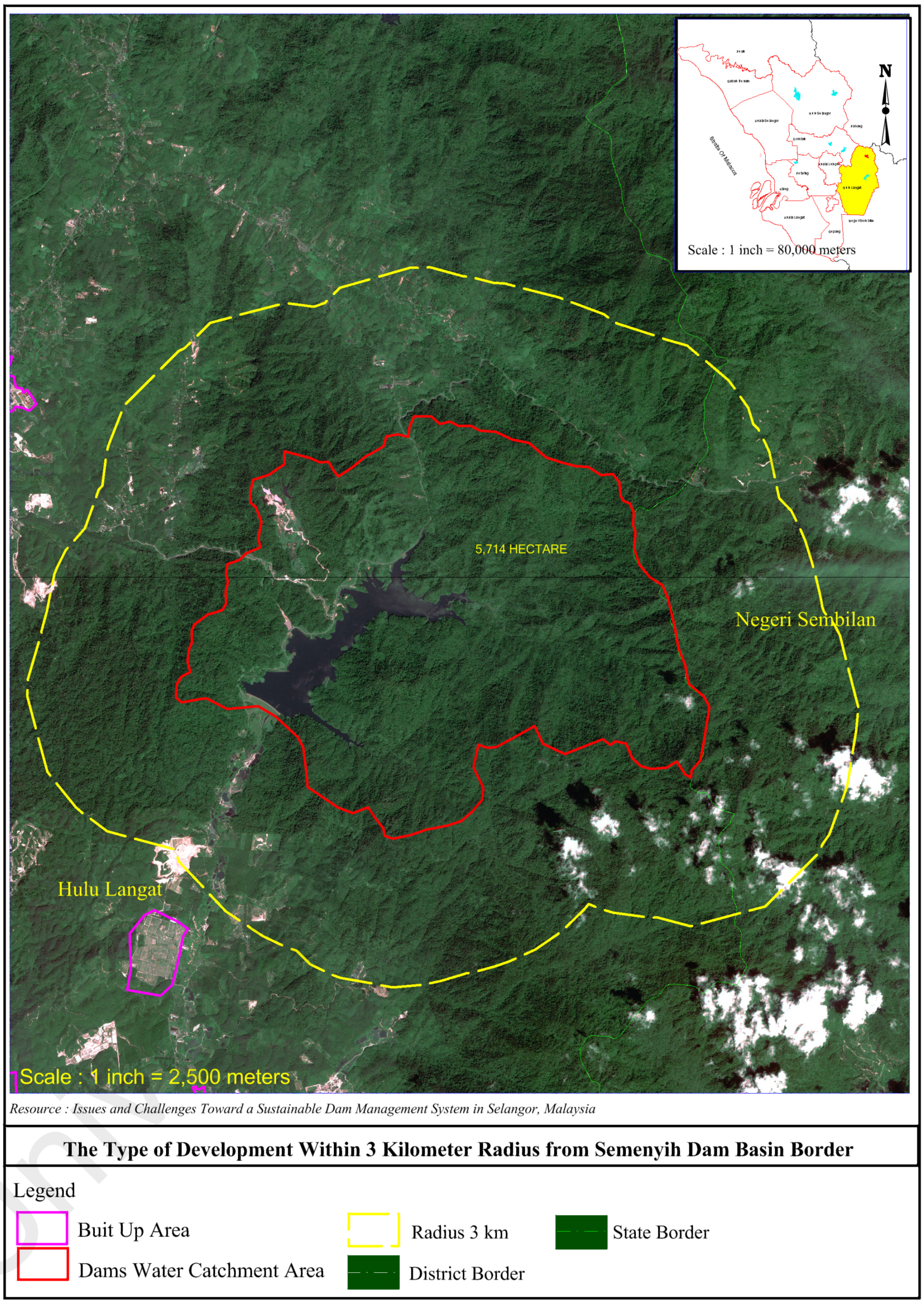


Figure 5.28: The Type of Development Within 3 kilometer Radius From Semenyih Dam Basin Border Map

5.3.2.8 Nearest Development Distance to The Selangor Dam Basins Border

Type of Development Within 3 Kilometers radius From Dam Basin Border, is to identify the dam where the closest urban areas. To get a clear picture, distance measurement, is involved within the development closest to the dam catchment area boundary. If there is development in the catchment area of the dam, then the distance is 0km. Figure 5. 29 shows the nearest dam to the urban area is Tasek Subang Dam, Batu Dam and Klang Gate Dam. And the dam located far from the development area is a Langat Dam, followed by Sungai Selangor Dam and Sungai Tinggi Dam.

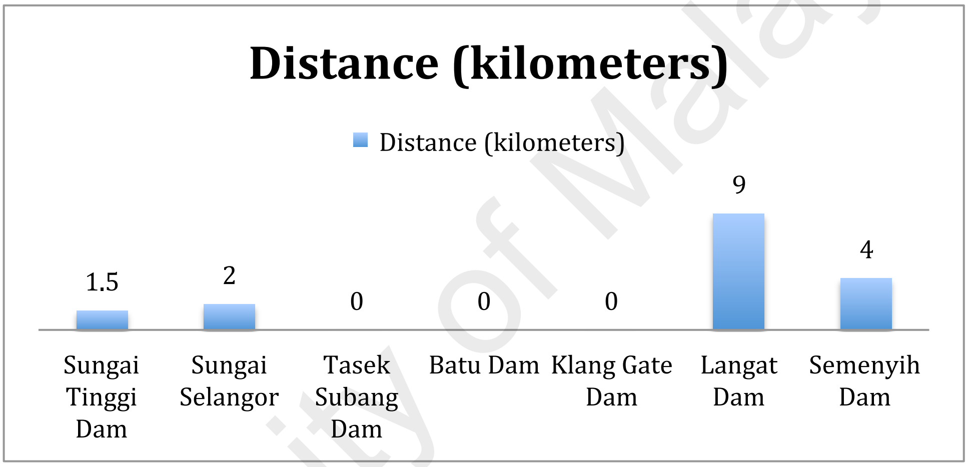


Figure 5.29: The Nearest Development Distance To The Selangor Dam Basin Border

So can be concluded that the Dam area surrounded by the urban area is a Tasek Subang Dam. The dam that are located at new development area and low density are is a Sungai Tinggi Dam and Sungai Selangor Dam, While The Dam that are located to near the urban area is a Batu Dam and Klang Gate Dam, and the Dam that are located far away from urban area is the Langat and Semenyih Dam.

Figure 5.29, shows the trend of development in Selangor are tent to approaches and surrounds the dam water catchment boundaries especially the old dam structure such as Tasek Subang Dam, Batu Dam and Klang Gate Dam. This situation becomes as a threats to the dam management systems. This trend reveals the dam area to the surrounding area. Besides development too close to the boundary of the catchment area will have a great impact on the dam water catchment area either in the form of human activity or physically exploring the area. Other wise Dam basin or dam water catchment area is a level 1 sensitive environmental area in a Malaysia National Physical Plan 3, there is no activity are allowed in the dam basin area excluded the research activity. Water quality is must maintained between class 1 and 2 in accordance with interim water quality standards. Any activity should be 100 meters wide form the dam water catchment buffer zone.

5.3.3 The Type of Land Use In Selangor Dam Basins

5.3.3.1 The Type of Land Use In Sungai Selangor Dam Basin

An area Sungai Selangor Dam basin is 20,219 Hectares. Sungai Selangor dam is located away from built-up area. Base on Figure 5.30, The type of land use in the the dam basin area, is Housing, Institutional, Community Facilities, Business, Services, Road, Forest and Water Bodies. The land use are not contradict with the dam basin area use is forest and water bodies. Forest category is PFE. There are 22 forest plots with a total area of 19,047.86 Hectares. The water body is in an area is 487.325 hectares. There are 4 types of land uses that conflict with the use of the dam catchment area, residential, institutional and community facilities, businesses and roads. Conflicting land-use distribution is concentrated in the area near to the dam water body and the areas that can access by road. There are have a two aboriginal settlements, Peretak and Geminchi Aboriginal Village. Aboriginal Village Peretak has 10 plots with a total area of 59.337 hectares. The Aboriginal Village Geminchi have 7 plots with a total area of 41.625 hectares. Area of land-use path is 99.093 hectares. The business area of land-use arises out of 0.729 hectares. The type of business is Chinese Private Schools. Community facilities and institutions land use are 34.912 hectares. It has three of the royal palace of 22.56 hectares, 0.726 hectares, 0.852 hectares. A statutory body of the dam operators is SPLASH, 10.162 Hectares. And last ones, Sri Berkat Welfare Home, of 0.135 hectares. Refer table 5.10 and figure 5.30.

Table 5.10: Land Use In Sungai Selangor Dam Basin

Land Use Type	Area /Hectare	% of Dam Water Catchment Area
Agriculture	25.70	0.13
Forest	19,047.86	94.1
Water Bodies	487.33	2.4
Residential (Aboriginal Village, Royal Palace,)	123.4	0.6
Business	0.73	0.004
Institution / Welfare Home	35.05	0.2
SLASH/Dam Operator	10.17	0.05
Road / Way	488.76	2.4
Total Catchment Area	20,219.00	100

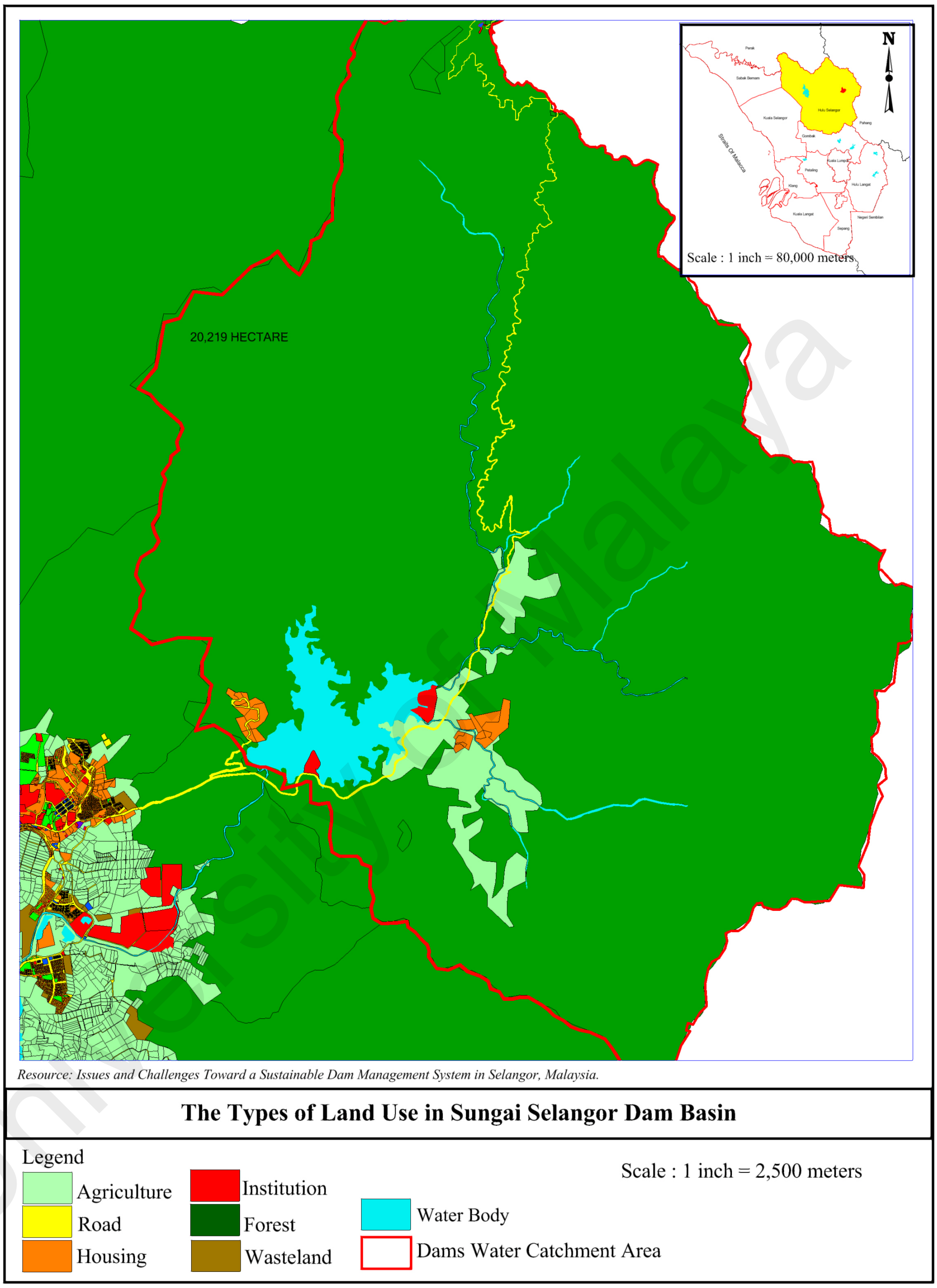


Figure 5.30: The Type of Land Use In Sungai Selangor Dam Basin Map

5.3.3.2 The Type of Land Use In Sungai Tinggi Dam Basin

Sungai Tinggi Dam Basin area was 3,962 Hectares. The land use landscape in the Sungai Tinggi this area, is represented by forest and agriculture land use. There's a few agricultural land use near to the dam water body. Agricultural area is 25.693 hectares of rubber plantations. Even though the dam was near to the north-south highway, the land use conflict just involved minor part of agriculture land. See Table 5.11 and figure 5.31.

Table 5.11: Land Use In Sungai Tinggi Dam Basin

Land Use Type	Area /Hectare	% of Dam Water Catchment Area
Agriculture	25.70	0.6
Forest	3,131.45	79
Water Bodies	804.85	20.7
Total Catchment Area	3,962.00	100

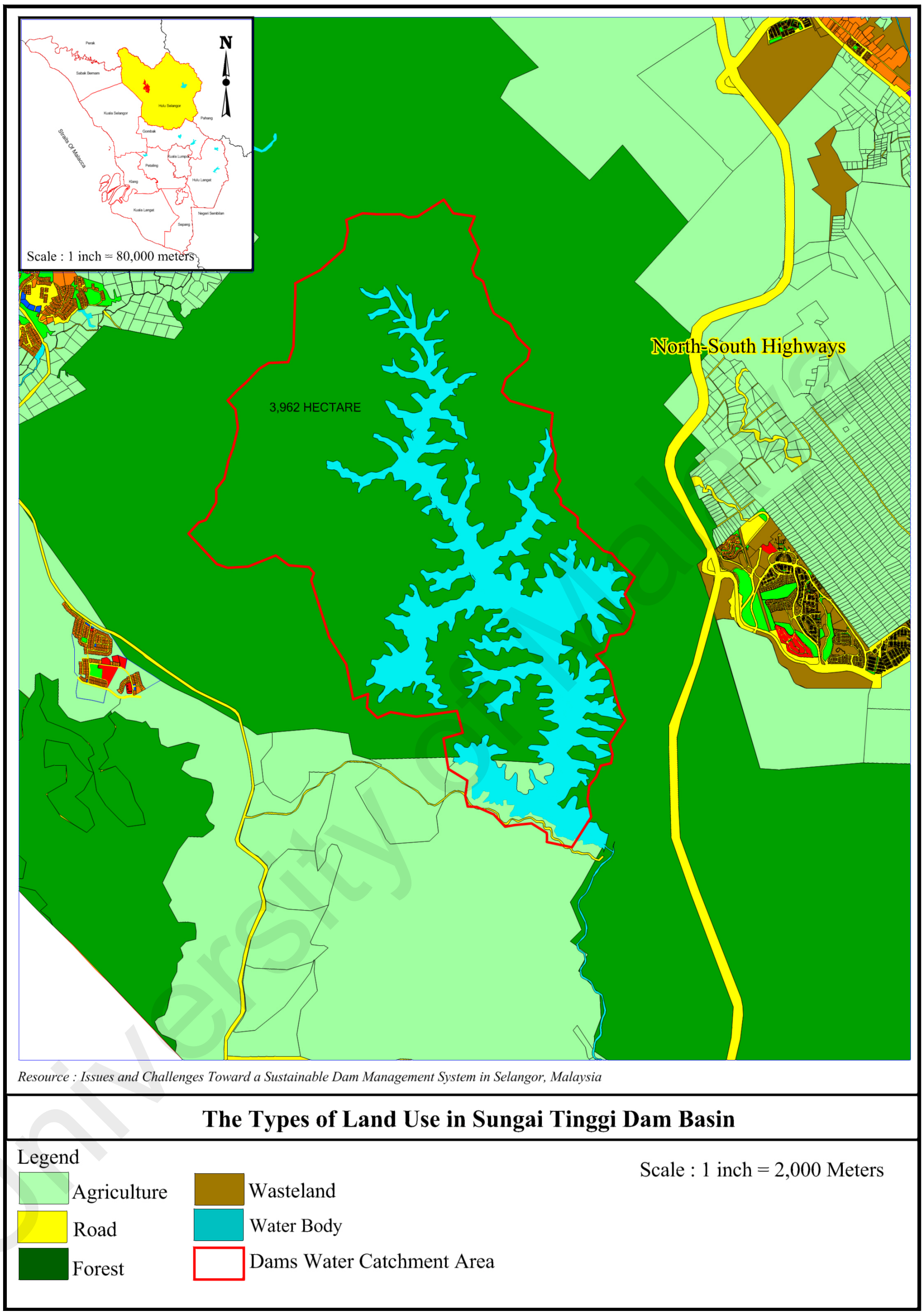


Figure 5.31: The Type of Land Use In Sungai Tinggi Dam Basin Map

5.3.3.3 The Type of Land Use In Tasek Subang Dam Basin

The Tasek Subang Dam Basin area is 1,007 Hectares. The Tasek Subang dam is surrounded by urban area. However, there are only a few agricultural land and housing within the boundaries of the Tasek Subang Dam Basin Area, See Tabel 5.12 and Figure 5.32. Agriculture is 18 plots of oil palm plantations with 27.72 hectares. While residential areas involved are 16.9766 hectares. The rest is forest water bodies land use. There is also a proposed land use of 15.51 hectares highway that passes through a small area.

Table 5.12: Land Use In Tasek Subang Dam Basin

Land Use Type	Area /Hectare	% of Dam Water Catchment Area
Agriculture	27.72	2.6
Forest	865.78	86.1
Water Bodies	81.02	8.0
Residential	16.97	1.7
Road / Way	15.51	1.6
Total Catchment Area	1,007	100

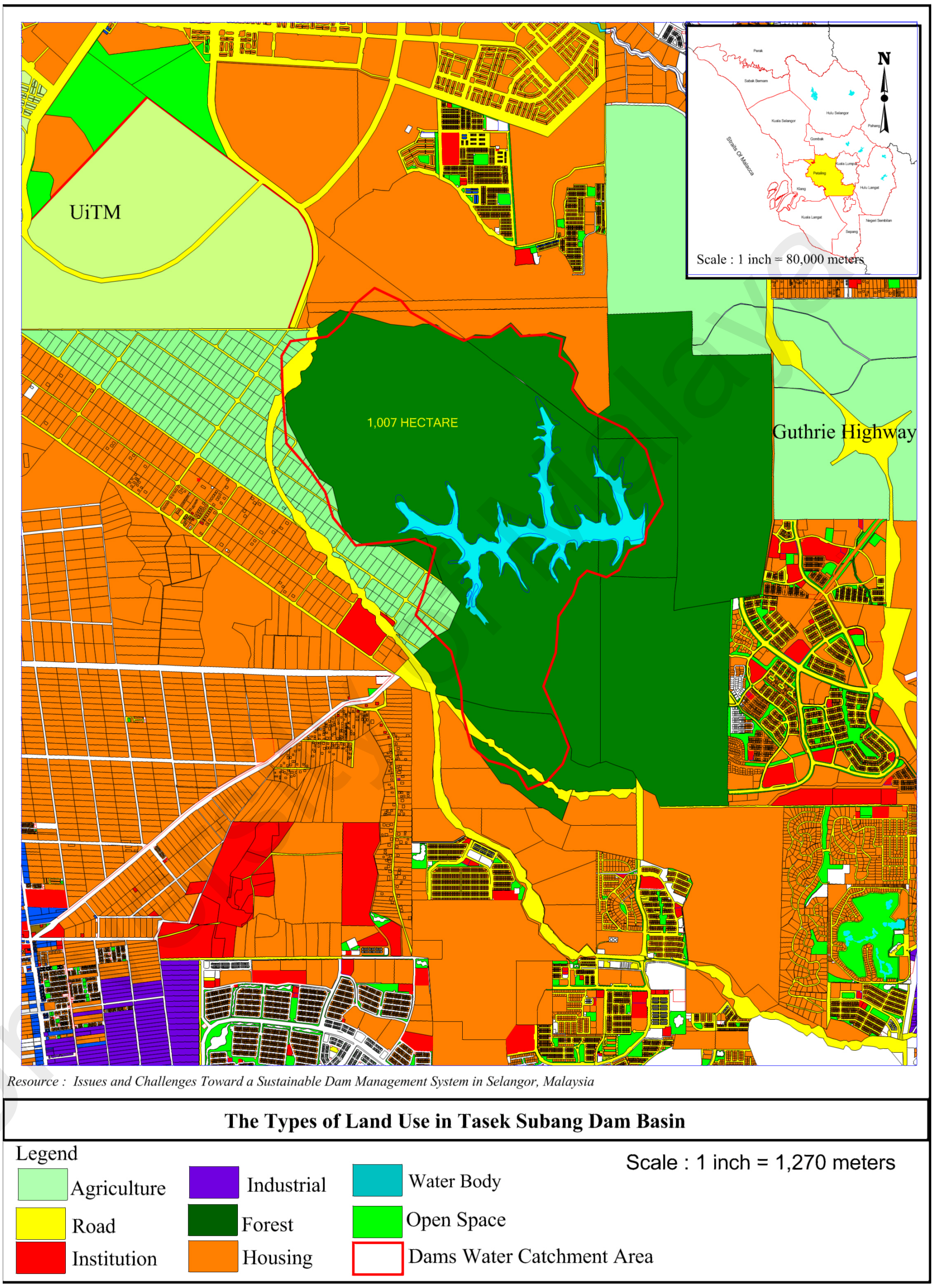


Figure 5.32: The Type of Land Use In Tasek Subang Dam Basin Map

5.3.3.4 The Type of Land Use In Batu Dam Basin

Batu Dam Water Basin area was 5,059 Hectares. Batu dams are close to an urban area. There have been many plots of agricultural land owned and accesses the road in in the dam water catchment. The roads also, close to the dam water body. See Figure 5.33 and table 5.13. There is Ulu Batu Aboriginal Village of 2.9089 hectares. There are 252 agricultural plots with a total area of 299.319 hectares. And there have 5 plots of road, with an area of 43.2662 hectares. Distribution of land use conflicts in the Batu Dam catchment area was located in the south and near the dam face.The level of land use conflict at Batu dam water catchment area is relatively Medium Conflict.

Table 5.13: Land Use In Batu Dam Basin

Land Use Type	Area /Hectare	% of Dam Water Catchment Area
Agriculture	299.32	6.0
Forest	4,458.88	88.1
Water Bodies	254.62	5.0
Residential (Aboriginal Village)	2.91	0.06
Road / Way	43.27	0.85
Total Catchment Area	5,059	100

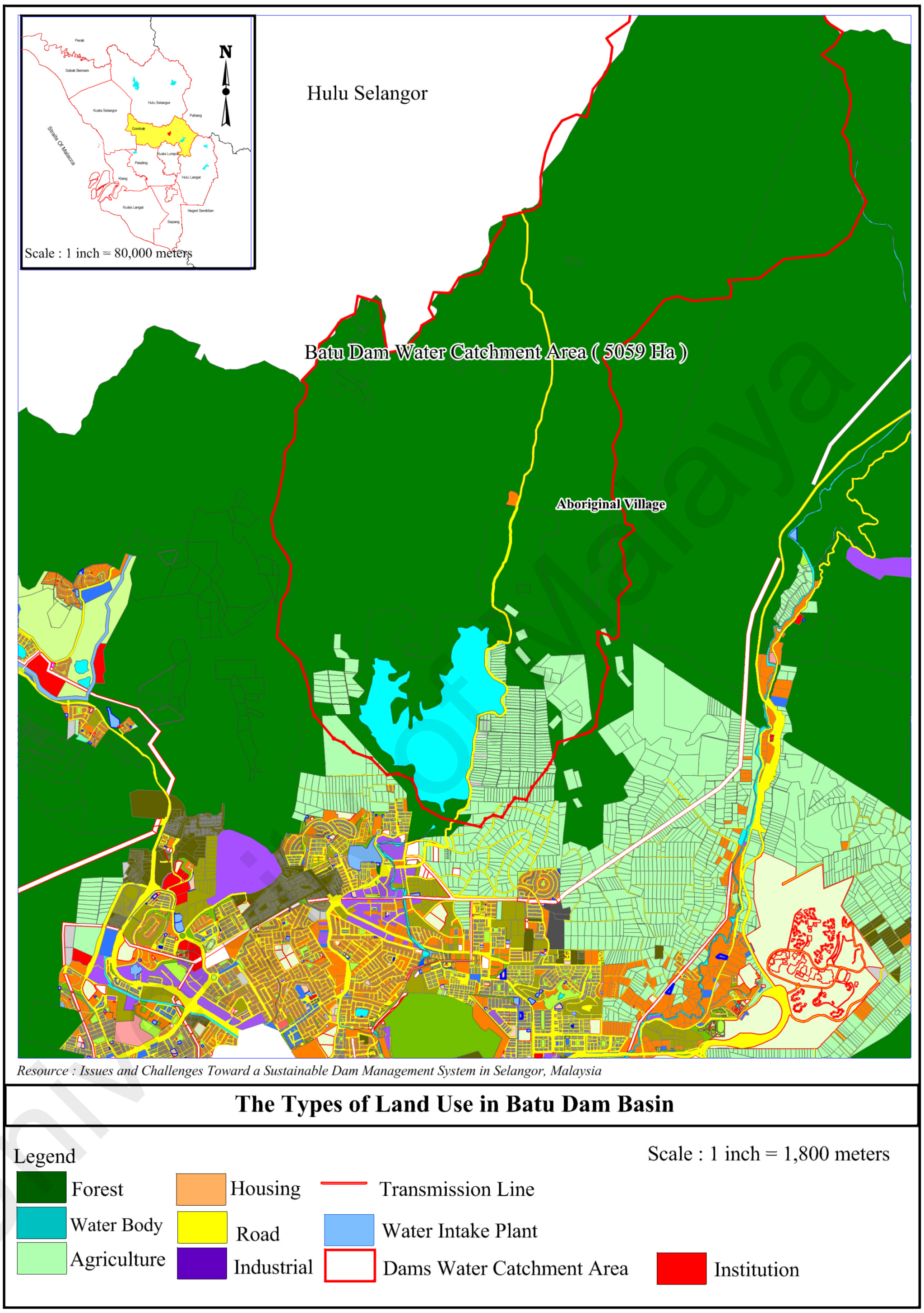


Figure 5.33: The Type of Land Use In Batu Dam Basin Map

5.3.3.5 The Type of Land Use In Klang Gate Dam Basin

Klang Gate Dam Basin area is 7,560 Hectares. Klang Gate Dam is a dam near to the Batu dam. And it is next to the urban area of Ampang Jaya and the City of Kuala Lumpur. In the catchment area of the dam, there are only six plots of agricultural lands measuring 4.5952 hectares. While the rest is a forest land use and water bodies. Water bodies and watersheds Klang gate dam is divided into two administrative areas of local authorities, Ampang Jaya Municipal Council and Selayang Municipal Council. See Figure 5.34 and table 5.14.

Table 5.14: Land Use In Klang Gate Dam Basin

Land Use Type	Area /Hectare	% of Dam Water Catchment Area
Agriculture	4.60	0.06
Forest	7,352.8	97.30
Water Bodies	202.60	2.64
Total Catchment Area	7,560	100

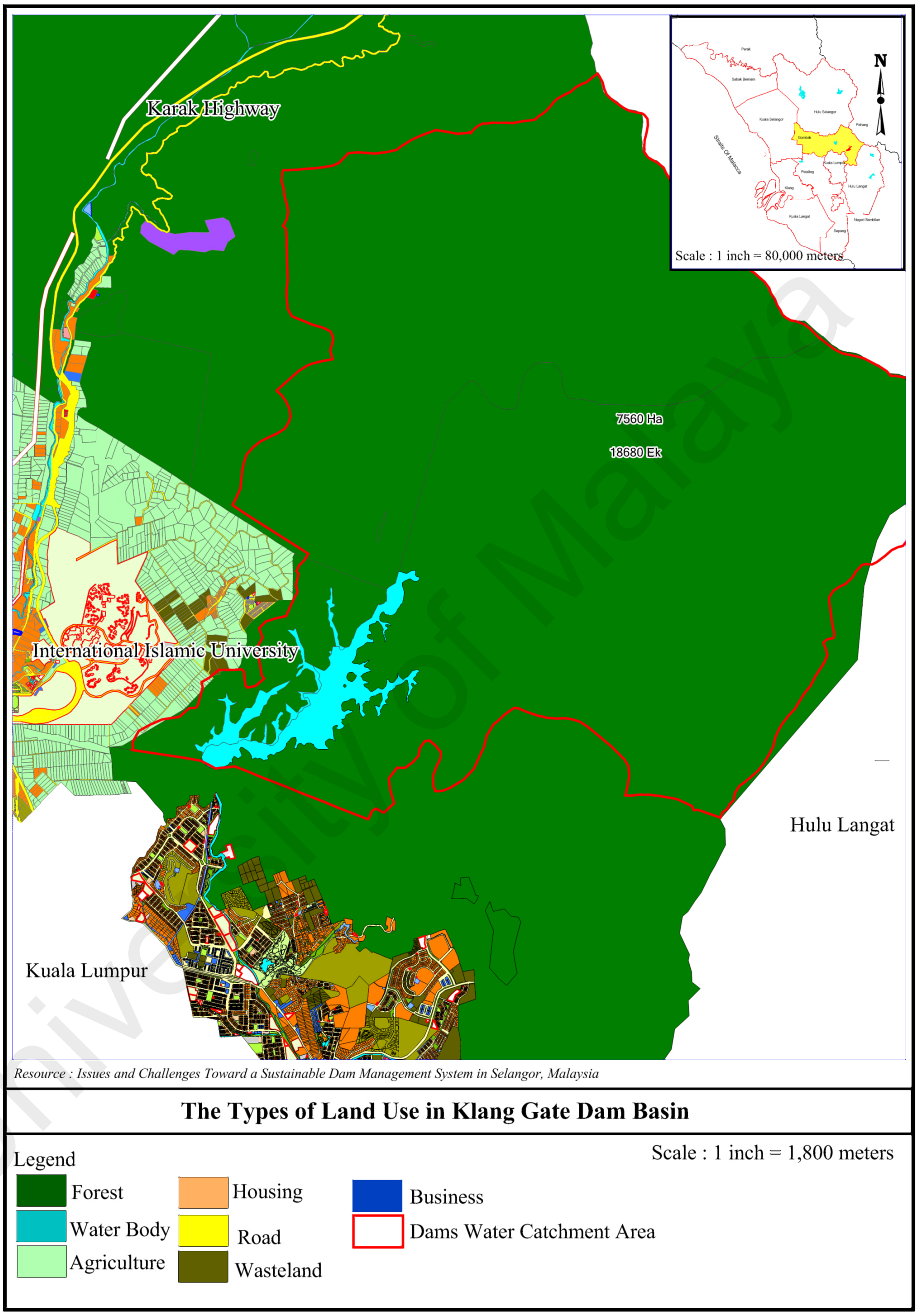


Figure 5.34: The Type of Land Use In Klang Gate Dam Basin Map

5.3.3.6 The Type of Land Use In Langat Dam Basin

Langat Dam Basin area was 4,169 Hectares. Overall dam basin area is protected by forest land use. Langat dam catchment area have no land use conflicts. The level of land use conflict at Langat dam water catchment area is not significant, See Figure 5.35 and table 5.15.

Table 5.15: Land Use In Langat Dam Basin

Land Use Type	Area /Hectare	% of Dam Water Catchment Area
Forest	3,967.98	95.18
Water Bodies	201.02	4.82
Total Catchment Area	4,169.00	100.00

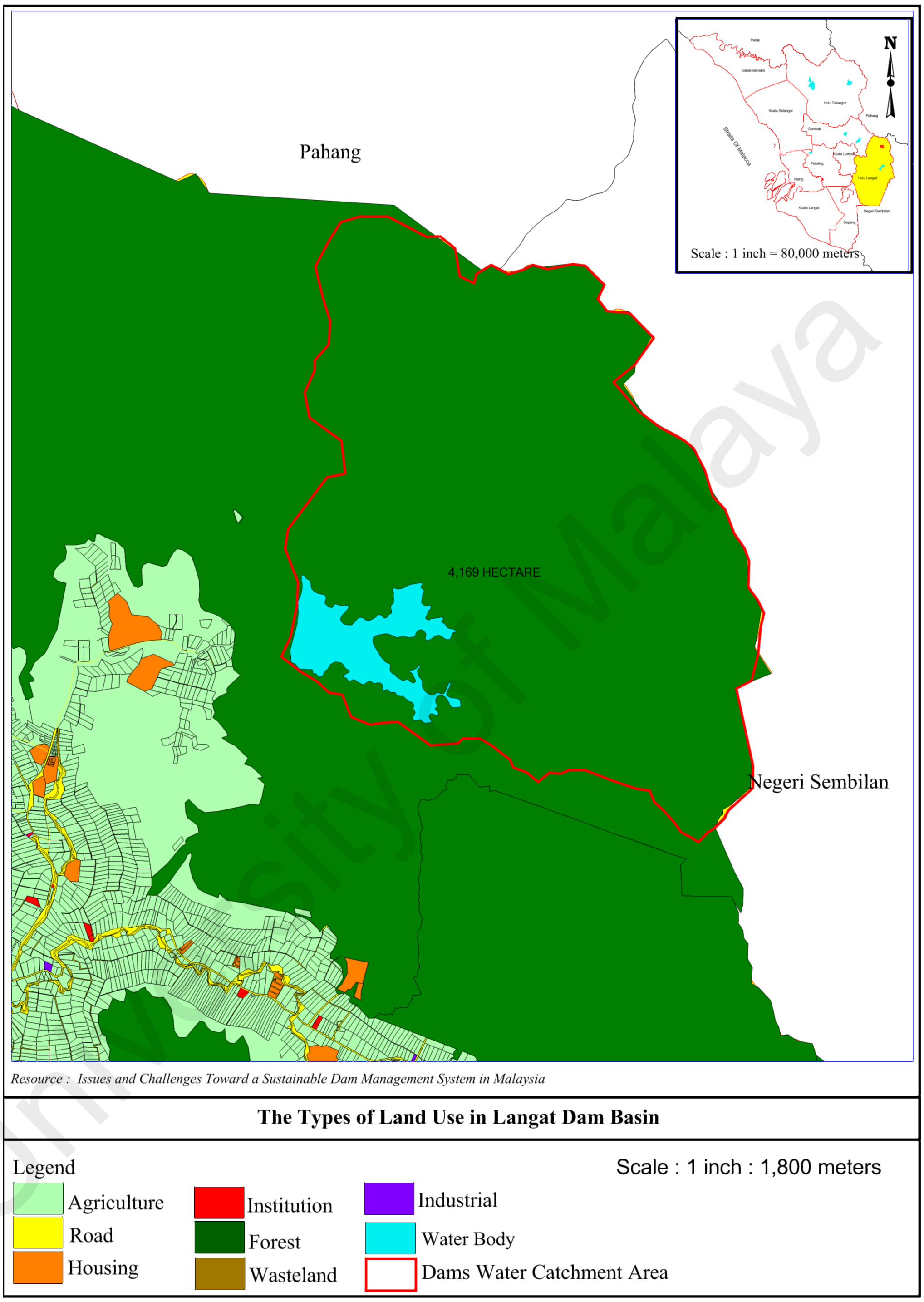


Figure 5.35: The Type of Land Use In Langat Dam Basin Map

5.3.3.7 The Type of Land Use In Semenyih Dam Basin

Semenyih Dam Basin area is 5,714 Hectares. Semenyih dam is located away from the urban area, however, there is a vast agricultural land use and public accesses the road in the dam water catchment area. See Figure 5.36 and table 5.16. There have been 50 plots of agricultural land with a total area of 278.87 hectares. Distribution of land use conflicts in the catchment area of the dam Semenyih concentrated along the Sungai Tengi road in the north.The level of land use conflict at Semenyih dam water catchment area is relatively medium.

Table 5.16: Land Use In Semenyih Dam Basin

Land Use Type	Area /Hectare	% of Dam Water Catchment Area
Forest	5,107.80	89.40
Agriculture	278.87	4.88
Water Bodies	300.73	5.26
Road / Way	26.60	0.47
Total Catchment Area	5,714.00	100.00

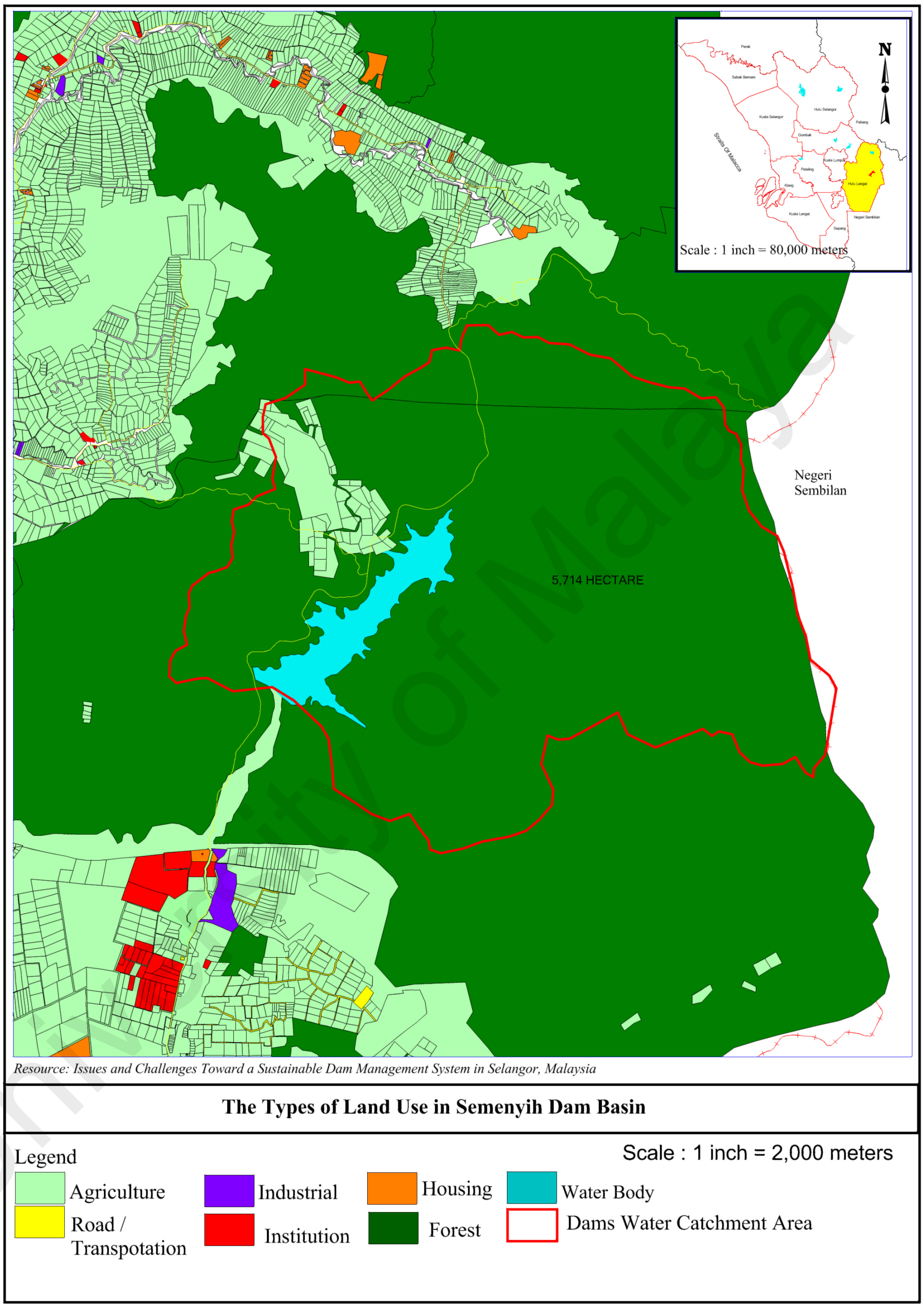


Figure 5.36: The Type of Land Use In Semenyih Dam Basin Map

5.3.3.8 Comparative Analysis - The Type of Land Use In Selangor Dam Basins

Based on the table 5.17, out of the seven major dams in Selangor, five dams have land use conflicts at lower levels. That is, Sungai Tinggi Dam, Tasek Subang Dam, Sungai Selangor Dam, Batu Dam and Semenyih Dam. Langat Dam and Klang Gate dam is the dam that did not have a conflict of land use in its catchment area.

Dams water catchment area in Selangor is facing a land use conflict. From five type of land use are contradict with dam catchment area, only four type land use, involved road, business, housing and agricultural. However the level of land use conflict is at low level because the percentages of conflict area are still small compared to the total area of the dam water catchment area.

Although the level of conflict in land use is still low, however, Selangor must implement preventive measures to avoid any nuisance in dam catchment areas. Land use contrary to forest and water resources will contribute to various activities that will cause problems and threaten the quality and safety of dam reservoirs.

Selangor should take steps not to allow for land use other than forests and bodies of water within the dam catchment area or if required to allow on condition, Selangor must provide a mitigation plans or pollution control plans or monitoring plans for all existing dams in Selangor.

Table 5.17 : Comparative Analysis - The Type of Land Use In Selangor Dam Basin

Dam																					
Land Use	**Sungai Tinggi**			**Sungai Selangor**			**Tasek Subang**			**Batu**			**Klang Gate**			**Langat**			**Semenyih**		
	%	**Scale**	**Score**	%	**Scale**	**Score**	%	**Scale**	**Score**	%	**Scale**	**Score**	%	**Scale**	**Score**	%	**Scale**	**Score**	%	**Scale**	**Score**
Industrial	**0.00**	**5**	**0**	**0.00**	**5**	**0**	**0.00**	**5**	**0**	**0.00**	**5**	**0**	**0.00**	**5**	**0**	**0.00**	**5**	**0**	**0.00**	**5**	**0**
Road / Utilities	**0.00**	**4**	**0**	**2.42**	**4**	**9.68**	**1.6**	**4**	**6.40**	**0.85**	**4**	**3.4**	**0.00**	**4**	**0**	**0.00**	**4**	**0**	**0.47**	**4**	**1.88**
Business	**0.00**	**3**	**0**	**0.004**	**3**	**0.01**	**0.00**	**3**	**0**	**0.00**	**3**	**0**	**0.00**	**3**	**0**	**0.00**	**3**	**0**	**0.00**	**3**	**0**
Housing	**0.00**	**2**	**0**	**0.85**	**2**	**1.7**	**1.7**	**2**	**3.40**	**0.06**	**2**	**0.12**	**0.00**	**2**	**0**	**0.00**	**2**	**0**	**0.00**	**2**	**0**
Agriculture	**0.6**	**1**	**0.6**	**0.13**	**1**	**0.13**	**2.6**	**1**	**2.6**	**6.0**	**1**	**6.0**	**0.06**	**1**	**0.06**	**0.00**	**1**	**0**	**4.88**	**1**	**4.88**
Forest	**79.00**	**0**	**0**	**94.1**	**0**	**0**	**86.1**	**0**	**0**	**88.0**	**0**	**0**	**97.3**	**0**	**0**	**95.18**	**0**	**0**	**89.40**	**0**	**0**
Water Body	**20.40**	**0**	**0**	**2.5**	**0**	**0**	**8.0**	**0**	**0**	**5.0**	**0**	**0**	**2.64**	**0**	**0**	**4.82**	**0**	**0**	**5.26**	**0**	**0**
Total	**100**	**-**	**0.6**	**100**	**-**	**11.52**	**100**	**-**	**12.40**	**100**	**-**	**9.52**	**100**	**-**	**0.06**	**100**	**-**	**0**	**100**	**0**	**6.79**
Total Score	**0.6**			**11.52**			**12.40**			**9.52**			**0.06**			**0.00**			**6.79**		
Score Percentage %	**0.6 / 2500 x 100 = 0.02**			**11.52 / 2500 x 100 = 0.46**			**12.40 / 2500 x 100 = 0.50**			**9.52 / 2500 x 100 = 0.38**			**0.06 / 2500 x 100 = 0.00**			**0 / 2500 x 100 = 0.00**			**6.79 / 2500 x 100 = 0.27**		
Rank	**Low**			**Low**			**Low**			**Low**			**Not Significant**			**Not Significant**			**Low**		

** Score is total of Scale multiply with total of %*

** % is the percentage of the area from total area of the catchment area of the dam*

5.3.4 The Type Of Land Ownership In Selangor Dam Basins

Type of Land Ownership in Dam Basin in Selangor will identify whether there is privately owned land in the dam basin area which gazette as a water catchment Protected area. To see tendencies and the relationship between land ownership status and interference or problem occurs. Dam catchment area should not have ownership of private land. It should be the government's land ownership on forest reserves. The map land title lot is from JUPEM, where the map is provided in the year 2009.

5.3.4.1 The Type Of Land Ownership In Sungai Selangor Dam Basin

There have 900 lots of private land In Sungai Selangor Dam Basin area. The minimum lot is approximately 0.039 acres, while the largest lot is 3,414 acres. Whole area amount of owned land in the dam basin area is 20,000 acres see (Figure 5.37).

5.3.4.2 The Type Of Land Ownership In Sungai Tinggi Dam Basin

In Sungai Tinggi Dam Basin area has only one owned land. The lot number is 30 and the total area of this lot 350 acres. However, this lot is only a small portion of land in the Sungai Tinggi Basin area see (figure 5.38).

5.3.4.3 The Type Of Land Ownership In Tasek Subang Dam Basin

At Tasek Subang Dam, there have a three lots of owned land in the dam basin area. The first lot is entirely included in the catchment area is 142.55 square acres. Second lot, is an area, 236.26 acres of which only partially included in the catchment area. While the third lot is 843.65 acres, only one quarter of lots included in the catchment area. Based on the surrounding development area, this lot has a potential to be a housing area see (Figure 5.39).

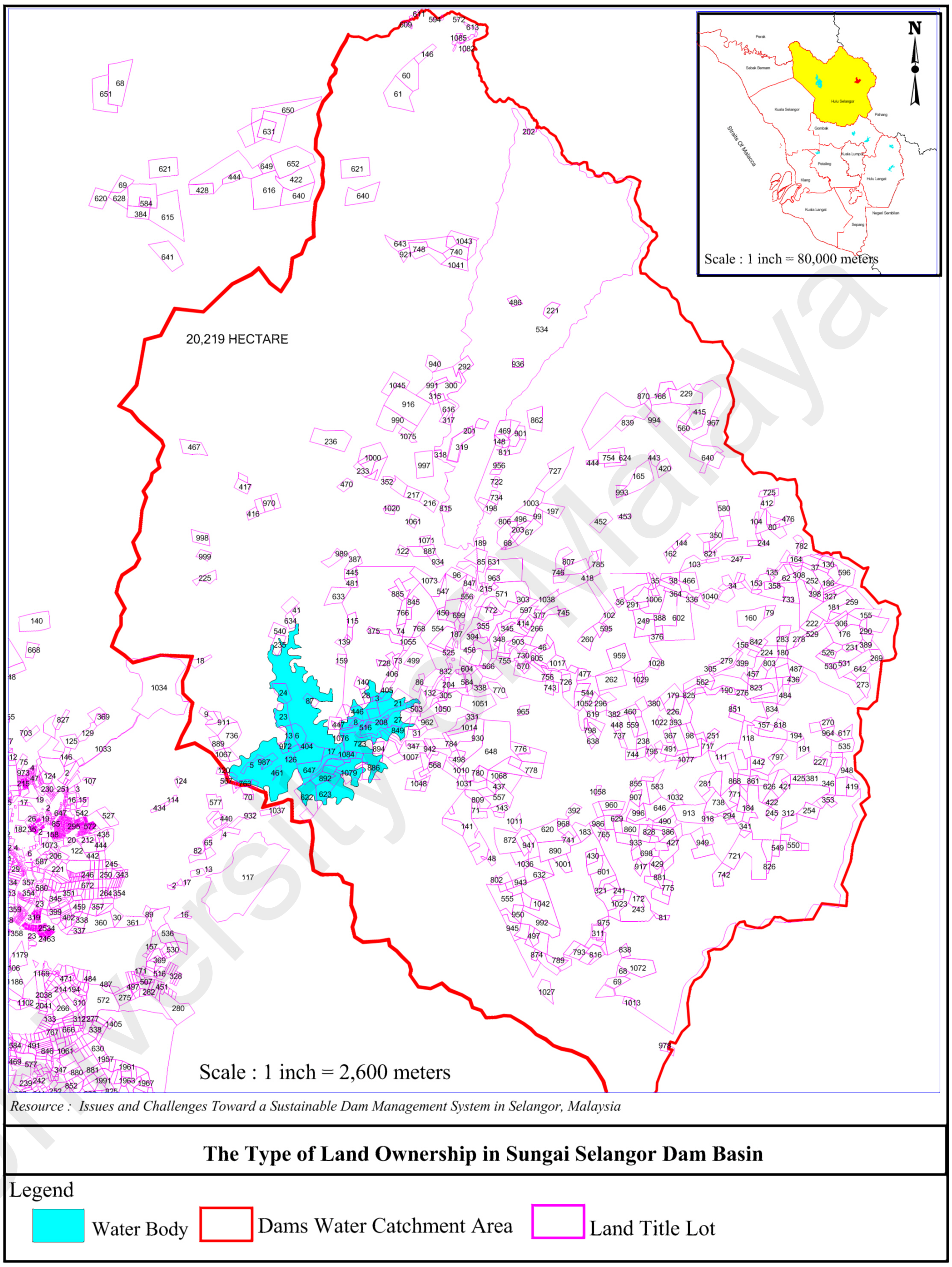


Figure 5.37: The Type Of Land Ownership In Sungai Selangor Dam Basin Map

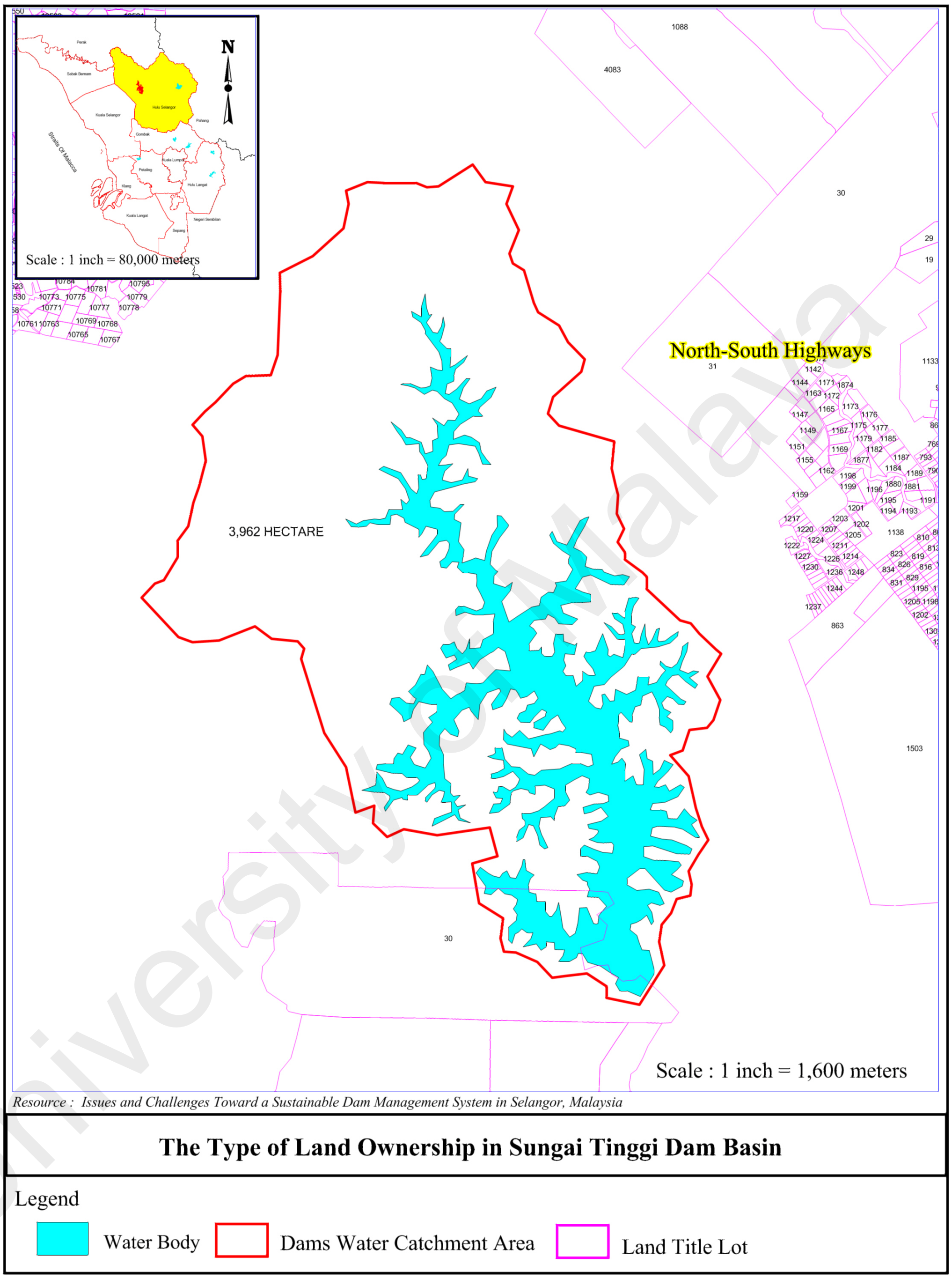


Figure 5.38: The Type Of Land Ownership In Sungai Tinggi Dam Basin Map

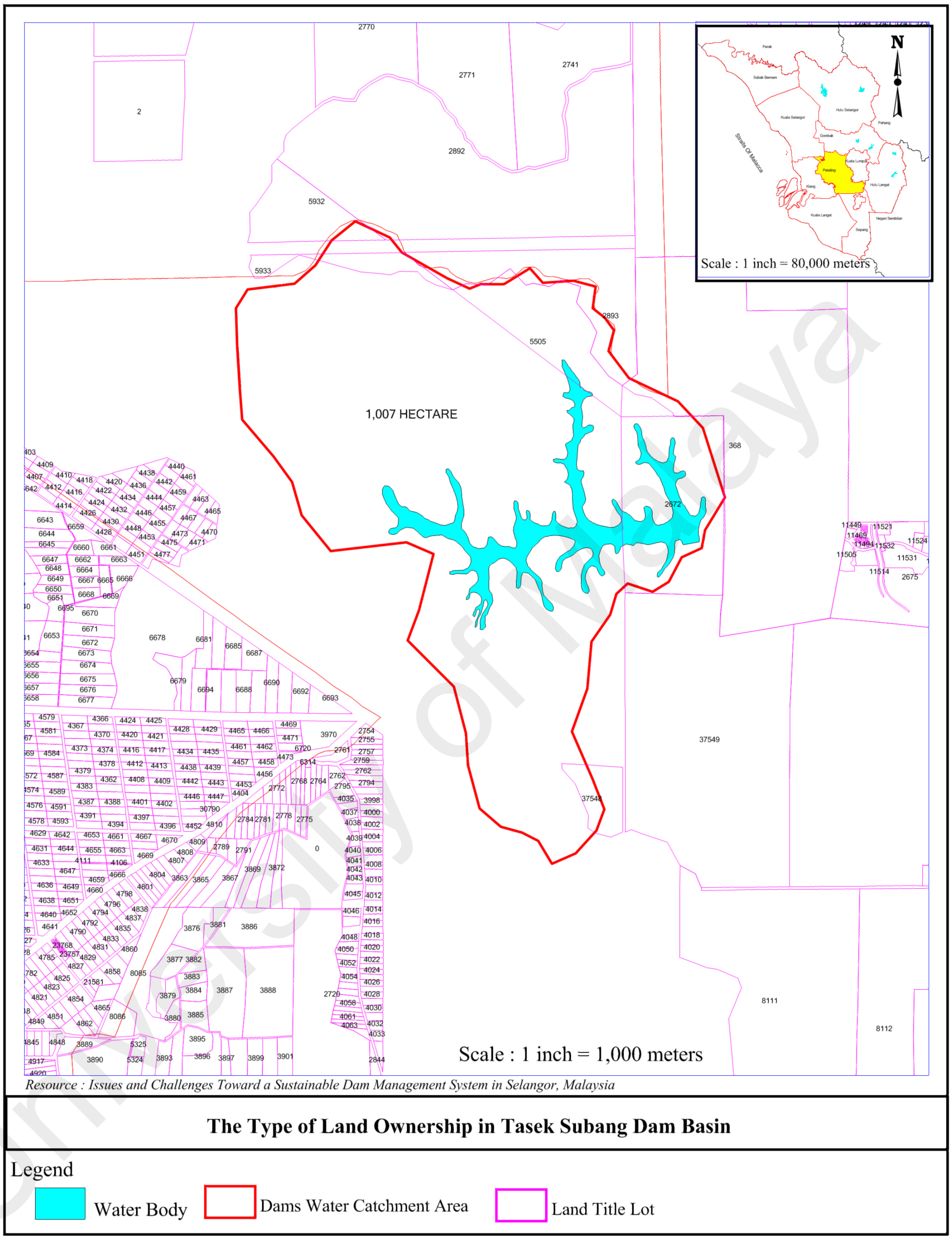


Figure 5.39: The Type Of Land Ownership In Tasek Subang Dam Basin Map

5.3.4.4 The Type Of Land Ownership In Batu Dam Basin

For Batu Dam Water Catchment Area, there were 724 privately owned lots of land in the watershed dams. Minimum lot size of land is 0.029 acres. While the largest size is 336.49 acres. Whole vast amount of available land in the Batu Dam Water Catchment Area is, 2,193 acres, see (Figure 5.40).

5.3.4.5 The Type Of Land Ownership In Klang Gate Dam Basin

While in Klang Gate Dam, there were 272 privately owned lots of land in the area of dam water catchment enacted by the Selangor Water Management Authority. Where the smallest lots size is 0.012 acres, and the largest land area is 78 acres. The total area of privately owned land in the watershed is the area of the dam, 1,052 acres, see (Figure 5.41).

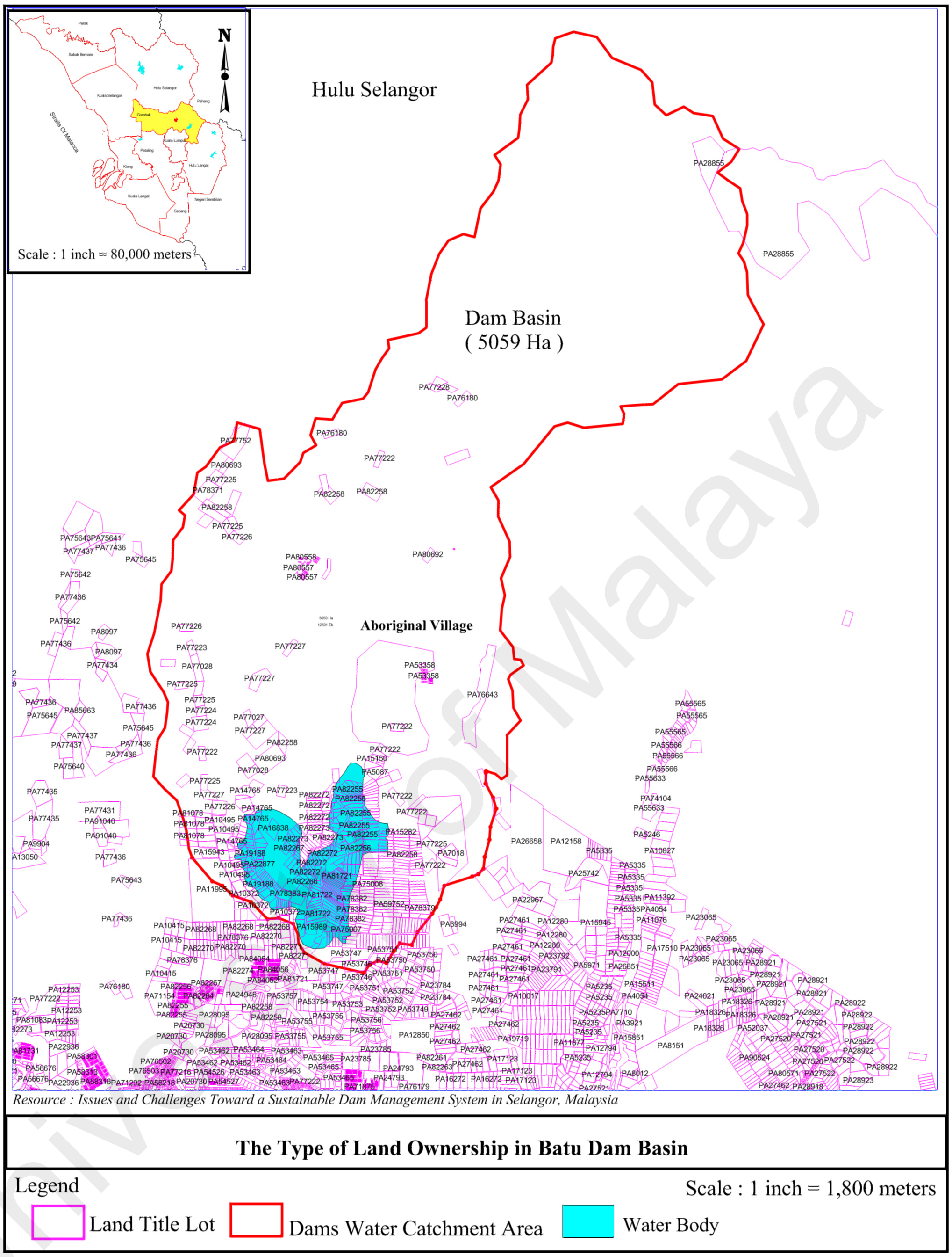


Figure 5.40: The Type Of Land Ownership In Batu Dam Basin Map

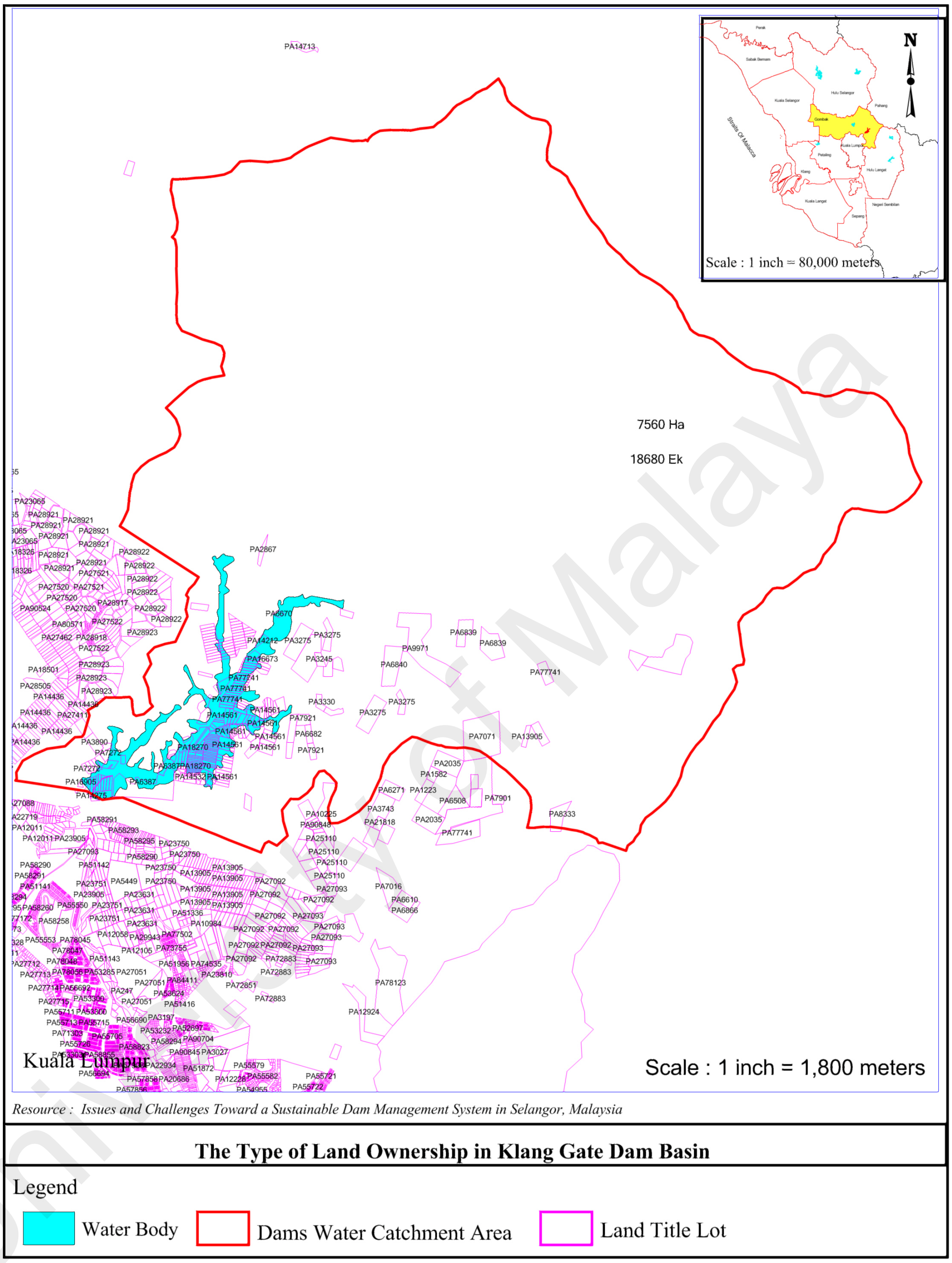


Figure 5.41: The Type Of Land Ownership In Klang Gate Dam Basin Map

5.3.4.6 The Type Of Land Ownership In Langat Dam Basin

The dam is located far from the development of the Langat Dam. There are only two lots of lands only in Langat dam catchment area. Where the largest area of the lot, 3.173 acres and is the smallest of the lot area, 3 acres only. Wide total lots only 6173 acres of lands only see (figure 5.42).

5.3.4.7 The Type Of Land Ownership In Semenyih Dam Basin

While the dam near the Langat dam, the Semenyih Dam, there have 60 privately owned lots of land in Semenyih dam catchment area. The smallest lots are 0.59 acres, while the largest lots measuring 236 acres. And the amount of the total area of land lots in Semenyih dam catchment area is wide, 786.83 acres (Figure 5.43).

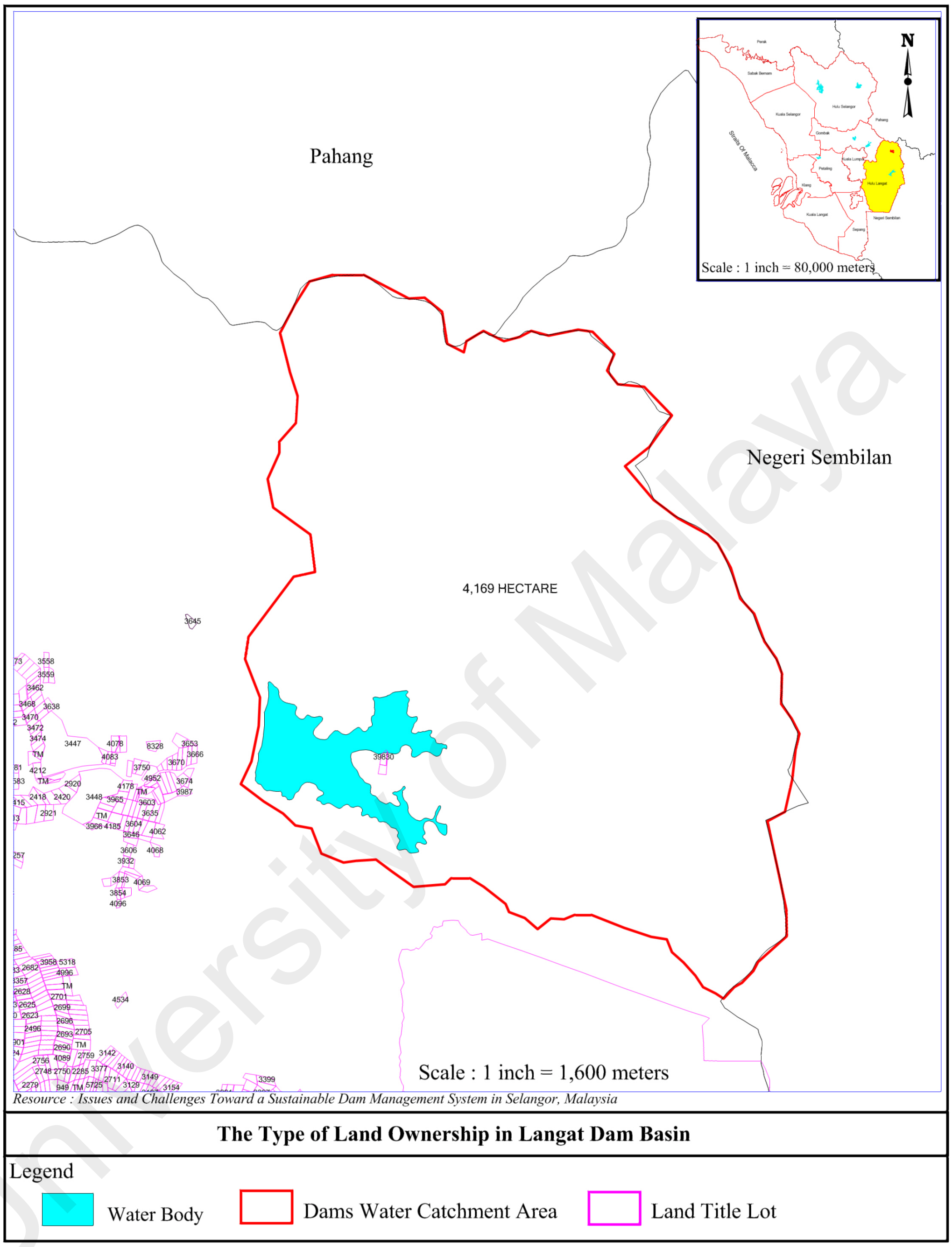


Figure 5.42: The Type Of Land Ownership In Langat Dam Basin Map

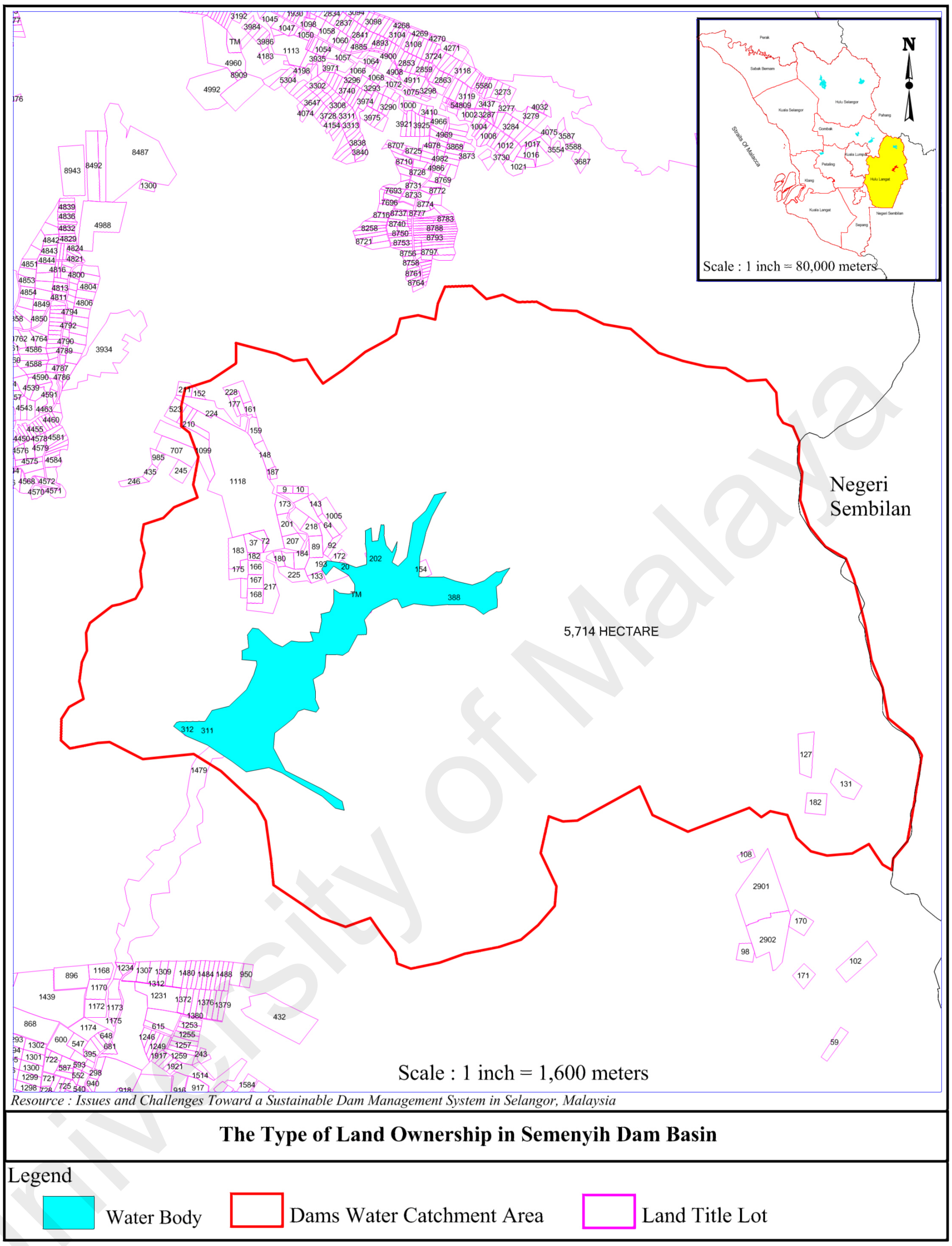


Figure 5.43: The Type Of Land Ownership In Semenyih Dam Basin Map

5.3.4.8 Comparative Analysis - The Type Of Land Ownership Selangor Dam Basins

.Table 5.18: Land Use In Semenyih Dam Basin

Dam	Watershaded Area (hectare)	Private Land Area (hectare)	Percentage (100%)	Rank
Sungai Tinggi	**3,962**	**141.6**	**3.6**	**Low**
Sungai Selangor	**20,219**	**8,093.7**	**40.0**	**Medium**
Tasek Subang	**1,007**	**190.8**	**18.9**	**Low**
Batu Dam	**5,059**	**887.5**	**17.5**	**Low**
Klang Gate	**7,560**	**425.7**	**5.5**	**Low**
Langat	**4,169**	**2.5**	**0.06**	**Low**
Semenyih	**5,714**	**318.4**	**5.6**	**Low**

Overall can conclude here that all water catchment dams in Selangor face problems of existence the privately owned land in the dam catchment areas. From four ranks of private land ownership 0 to 3, 0 is not significant, 1 is low, 2 is medium and 3 is high. There have been only two low and medium rank in Selangor. Sungai Selangor Dam is higher dam with the total of private land ownership is medium rank with 900 lots. Others dam are in low rank. Sungai Tinggi Dam is only one lot, followed by Langat Dam with two lot and third is Tasek Subang Dam there only 3 lot only. Semenyih Dam where there have 60 lots in Semenyih Dam Water Catchment Area. Batu Dam of 724 lots and third is Klang Gate Dam of 275 lots in Water Catchment Area.

CHAPTER 6: DISCUSSION

6.1 Introduction

This chapter will discuss and compare the final model with the working model. The discussion will follow the research objective and the keyword on a theoretical model and final model. 1st is The Main Characteristics Of Dams In Selangor, 2nd The Issues in The Selangor Dam Basins, 3rd The Existing Dam Management Systems In Selangor, which involved the challenges and the evaluation of existing dam management system and 4th The Sustainable Dam Management System Model For Selangor. The comparison, between working model with final model for each keyword as shown on figure 6.1.

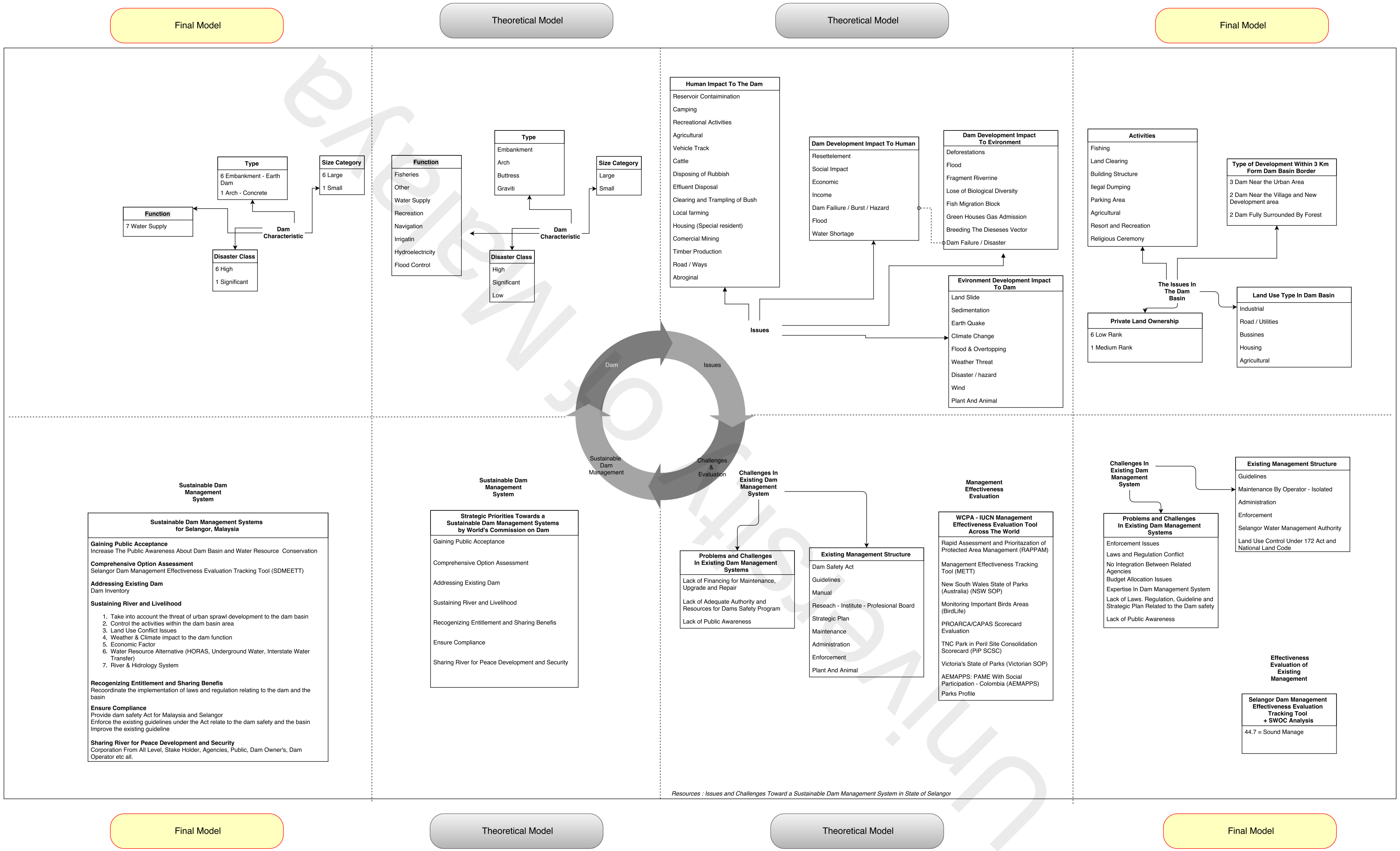


Figure 6.1: Theoretical Model and Final Model Comparison

6.2 The Main Characteristics of Dams in Selangor

In term of size category, sixes dams in Selangor are in large size category, accept the Tasek Subang Dam in the small category. From four type of dams made by human, arch dams, gravity dams, embankment dams and buttress dams, (Leliavsky, 1981), all dam in Selangor are Earth Embankment Dam accept the Klang Gate Dam with the Concrete Reinforced Concrete Dam type. Others dams, Sungai Tinggi Dam, Sungai Selangor Dam, Tasek Subang Dam, Batu Dam, Langat Dam and Semenyih Dam was built from natural material included the earth fill dam and rock fill dams same as definition of embankment dam from the British Dam Society about the embankment dam, where, Embankment dams are mainly made from natural materials. The two main types are earth fill dams and rock fill dams. Earth fill dams are composed mostly from compacted earth, while rock fill dams are made up mainly from dumped and compacted rock fill (Society, 2012). While concrete dam type for Klang Gate Dam Structure is Dam in the Arch Dam type, where Arch dams are made from concrete. An arch is a strong shape for resisting foreign pushing force of the water behind the dam. Arch dams are generally constructed in narrow, steep sided valleys. They need good rock for their foundations, and on the sides of the valleys, to resist the forces on the dam (Society, 2012). The elevation of the dam structure in Selangor is between 9 meters high of 110 meter. Where the highest is Sungai Selangor dam of 110 meters high, followed by Langat Dam and Sungai Tinggi Dam, with 61 meter and 57.5 meter high. Semenyih Dam was a 49 meter high and followed by Batu Dam and Klang gate dam 44 meter and 36.8 meter. The shortest dam elevation is a Tasek Subang Dam was a 9.1 meters. Refer to the Definition by New Hampshire’s Departmental of Environmental service, Dam" means any artificial barrier, including appurtenant works, which impounds or diverts water and which has a height of 6 feet or more, (Water Management And Protection) that shows that all dam in Selangor are full fill this definitions in term of the dam structure elevation. All dam in Selangor is also fulfilling the Definition of, U.S National Dam Safety Program Act (2000) to the elevation of the dam, that is 25 feet or more. Where the lowest dam structure in Selangor is Tasek Subang Dam of 27 feet high. In term of disaster class, all dam in Selangor is high disaster class. Accept the Sungai Tinggi Dam was a Significant Disaster Class. Where is Significant disaster class is dams where failure or miss-operation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. The high disaster class as those where failure or miss-operation will probably cause loss of human life.

Dams form an essential part of the infrastructure in many countries. Control of water, whether for agriculture, public or industrial supply, or flood alleviation is a prerequisite for social and economic development (Midttomme, 2001). Global view they have a majority of dams in the world are built for hydropower and electricity. Second is for irrigation, 3rd for flood control and 4th for water supply. Countries with the most dams are United State of America, Second is in Europe, 3rd in Mainland China, follow by India, South Africa and South America. In Selangor, all dams in Selangor functions as a water supply and there have been only one dam are used for water supply and the flood mitigation on the same time it is a Batu Dam. Compared with global view of the majority of dam function in the world are for hydropower and electricity

6.3 The Issues in the Selangor Dam Basins

Table 6.1 is shows the comparison of the result from all research question under 2nd research objective (To Examine the Issues in The Selangor Dam Basins). This comparison is made to look at the relationship between activity and the interference issues in the dam area with the dam location factor, access factor or land ownership factor in the area of the dam.

Table 6. 1 : Relationship Betwen Activity and The Interference Issues In The Dam Area With The Dam Location, Access and Land Ownership Factor

Dam	Interference / Activity	Land Use Conflict	Public Accesses	Land Title Lot	Nearest Development
Sungai Selangor	Low	Low	Yes	High	Far
Sungai Tinggi	Low	Low	No	High	Far
Tasek Subang	Low	Low	No	Low	To Near
Batu	Medium	Low	Yes	Low	To Near
Klang Gate	Low	No Significant	No	Low	To Near
Langat	No Significant	No Significant	No	Low	Far
Semenyih	Low	Low	Yes	Low	Far

Three of dams in Selangor are located near to the urban area which one dams are located surrounded by urban area. Batu Dam and Klang Gate Dam that near the built up area, and Tasek Subang Dam the only one dam that is surrounding the built up area or urban area. Even the dams are located in the urban area, without the public accesses such as a Tasek Subang Dam, not occur Issues and problems of Interference. Compared to Batu Dam because that area has a Public Accesses. It's contrast to Klang Gate Dams, even Klang Gate dams don't have a public accesses, they still face an Issues and problems of Interference, because Klang Gate Dam is located at the quartz ridge that into the pull of the tourist center. While the other four dams located far from urban areas, showing same trend where the dams that have a public accesses face an Issues and problems of Interference in the dams are even though they are located far from urban areas, such as a Semenyih and Sungai Selangor Dam. While Langat Dam and Sungai Tinggi Dam without the public accesses has no face an Issues and problems of Interference. In Selangor Dam Area. That shown that a factor of the issues and problems of interference in the dams are not caused a location of the dams but the public accesses to the dams, this statement are contradict with early research hypothesis, that the dam close to built-up areas are more vulnerable to threats. And it shown that the independent variable in this study is a road or public accesses to the dam is not a dam location, and the interference of the dam area is a dependent variable in this study.

The land title lot in dam water catchment area also give an influence to the interference issues, where for three dam such as a Tasek Subang Dam, Sungai Tinggi Dam and Langat Dam which has small unit of land title lot in their Dam Water Catchment area are not facing of interference issues. And this statement will support the situation for Klang gate Dam where even though they have no road in their water catchment area, but there are still facing the interference problem because they have a lot of land title in the Klang Gate Water Catchment area. And that shows that the factor of interference issues in the dam water catchment area in Selangor is a public access and there have a lot of land title lot in the dam water catchment area.

All issues happened in dam basin in Selangor, shows that the human give an impact to the dam in term of land use conflict, urbanization depression, anglers, illegal dumping, agricultural activities and others, that shows that there have a new issues in dam research and filling the knowledge gaps about the relationship theory between the dam, human and environment that has been discus before. Where dam where give and impact to the environment and social impact (Lerer & Scudder, 1999). Impact of the dam to the human is resettlement by (Bartolome *et al.,* 2000) and (Jackson & Sleigh, 2000). Lowered living standard by (Dorcey *et al.,* 1997). Dam also give and impact to the environment in term of changes of river and ecology by (Vaikasas & Rimkus, 2011), (McCully, 2001), (Sedell *et al.,* 1990), about the sediment impact in the river, dam fragment the fluvial system by (Graf, 1999). Changes of hydrological river system by (Wang et al, 2004), dam are also become a breeding ground for disease vector such as malaria by (Ripert & Raccurt, 1987), (Ghebreyesus *et al.,* 1999), (Mouchet & Carnevale, 1997) and (Fenwick, 2006). impact of dam to environment are contribute with the green houses gas admission (Gunkel, 2009), (Lima et al, 2008) and (Gagnon et al, 1997). Fish block impact (Larinier, 2000) and (Jackson & Marmulla, 2001). The impact of the dam that give an impact to the both human and environment is a dam burst or failure, (Washington Military Department, 2013). In reversed aspect environment also contribute the impact to the dam where, they give an impact in term of land slide problems, (Korup, 2002) and (Dunning *et al.,* 2006). Earth quake also contribute the impact to dam structure, (Leliavsky, 1981), (Dai et *al.,* 2005), (Pal, 1974), (Makdisi & Seed, 1977) and (Morrison *et al.,* 1977). Climate change also give an impact to the dam, (Ficke *et al.,* 2007) and (Wang et al, 2006). The last impact of the environment to the dam is plant and the animal, by (FEMA, 2005).

Dam issues in Selangor are more related to human activities, within the dam basin, such as the fishing, illegal dumping, agricultural, land clearing and etc all. All the activities are supported by the ways and road in the dam basin area.

In term of land use issues, Land use conflict issues at dam water catchment area in the review of literature notice that there have ten type of land use and activities conflict in dam water catchment area. 1) Recreational Activities, 2) Cattle, 3) Agricultural 4) Special Resident (luxury resident), 5) Road and Ways, 6) Native title and aboriginal, 7) Unregulated off-road vehicle use, 8) Commercial/mining 9) Private Land and 10) Timber production. From ten types of land use, dam basin in Selangor only facing by the land use conflict issues in seven type of land use conflict. It involved recreational, agricultural, road and ways, native title, unregulated off-road vehicle use, commercial and private land. And the level of land use conflict and conflict of activities in Selangor dam water catchment area overall is in a low level because the percentage of the conflict area is still small compares to the total area of dam water catchment.

6.4 The Existing Dam Management Systems in Selangor

Compare with the administration and management of dams in advanced countries like the U.S. and Australia, Malaysia or Selangor to press a bit behind in terms of the provisions of the Act and related laws. Where management of reservoirs in Selangor is more to administrative dam structure alone. Dam management is not comprehensive and do not include its water catchment management. Where the structure of the dam and the catchment area were managed by different agencies, which have functions and duties not be integrated together. This situation invites a lot of problems, especially in terms of enforcement of nuisance in the catchment area. Compared to the United States and Australia, they have a special act relating to the safety of the dam which is referred to as, the Dam Safety Act. Where the act has set the establishment of a joint committee involving all the agencies involved in the management of the dam, including the authority managing the case management. This committee is responsible for performing dam safety program that has been put into the Act. The Committee is also responsible for coordinating and providing guidelines and standards for the management of the dam. The committee is chaired by FEMA or if the Malaysian equivalent of the National Security Council. In Selangor there have a lot of regulation conflict in land use control and management at the dam water catchment where, even though SWMA has gazette the dam water catchment area as a preserve are, but there have a contradict with the zoning under Act 172 where some are in dam water catchment area are zone as a agricultural, housing and infrastructure activities. Enforcement problems by SWMA become even more complicated when there is too many owned land in the dam water catchment area of the dam. This clearly shows significant weaknesses in the management and administration of the dam in Selangor are no integration or cooperation between the agencies involved and the coordination of the implementation of the act and the law in regards land use control watershed dams. And the cause of why the lack of cooperation and integration between the agencies involved is because there is no specific provision of the Act relating to the safety of the dam and its catchment

Compared to typical problems in challenges in dam administration and management, Selangor state are facing more such as enforcement issues, Laws and regulation conflict, have no integration between related agencies, budget and allocation issues, shortage of expertise in dam management fields, and lack of public awareness. The major issues are Selangor and Malaysia also has no Act related to the dam safety. The existing guidelines in dam management system in Selangor and Malaysia are not enforceable under any related laws. Selangor also has less guideline, manual and strategic plan.

To evaluate the existing sustainable dam management systems in Selangor this study has used the Selangor Dam Management Effectiveness Tracking Tool (SDMETT). The Existing Dam Management System in Selangor gets a score at 44.7 in the category of "Sound Manage". Compared to other protected area management evaluation tool that inspired from IUCN, The Selangor Dam Management Effectiveness Tracking Tool (SDMETT) is designed for the dam management system its self. In others tool dam is become the threats to the protected area but in SDMETT, the threats for the dam basins is come from the human activities and the land use.

6.5 The Sustainable Dam Management System Model for Selangor

Toward a sustainable dam management system, World Commission on Dam has, sets out this constructive and innovative way forward for decision making in to the dam and water resources management in the form of the seven strategic priorities. (1) Gaining Public Acceptance; (2) Comprehensive Options Assessment; (3) Addressing Existing Dams; (4) Sustaining Rivers and Livelihoods; (5) Recognizing Entitlements and Sharing Benefits; (6) Ensuring Compliance, and (7) Sharing Rivers for Peace, Development, and security. While Toward a Sustainable Dam Management Systems Model for Selangor, The Selangor still need to follow the seven strategic policy but the priority is a quite deference since Selangor Dam Management in Selangor have their own strength, weaknesses, opportunities and the constrains. Where, the management of dams in Selangor needs improvement in terms of coordination of the implementation of the laws and regulations between the agencies involved. Management of dams in Selangor in particular and Malaysia in general, should also provide some guidelines and standards regulations to operators and owners of the dam. The same as in the U.S. dam is held and operated by various agencies. For example in Malaysia, the National Energy Company, DID Federal and State Government. The professional body for the management of the dam at ASDSO in America and ANCOLD in New South Wales, the establishment of such a body suitable for long term planning in dam management in Malaysia, after the existing management system improved. Furthermore, Selangor and Malaysia have a number of dams that still small compared to other developed countries like the United States. Lastly the system in Selangor and Malaysia should be in line with the seven key strategies in sustainable dam management policies set by the world commission on Dam.

6.6 Conclusions

Management system of dams in Selangor has an advantage compared to other countries. Malaysia was less vulnerable to disasters such as earthquakes, storms and so on. While, the number of dams in Malaysia is still small in number and can be fully monitored. Furthermore, Malaysian privately owned dams are not allowed, then the condition is more easily compared to other countries such as the United States, with nearly 80 000 dams including private dam. Weaknesses of reservoirs of Management in Selangor are about the coordination and integration between the agencies involved. In Selangor and also in Malaysia, has no special act established related to the dam safety in regards to coordinating the duties and responsibilities of each agency involved. Other than the state of Selangor is a rapidly developing and constraints in terms of areas suitable for development. The rapid development has given rise to a conflict of interest between land development and watershed conservation. Development is the need to accommodate the increase in population and at the same time also the source of water supply is also something important to the continuity of development and needs of the urban population. Instead of sources of drinking water supply, Serge Clean water is the lifeblood for high-tech industries development that is booming in the state of Selangor. Selangor therefore must take steps to implement sustainable land use controls specifically in regards to dam catchment area in order to maintain continuity of water supply in the future. Awareness among the general public is another step that must be well in reservoir management, as based on field research and interviews among enforcement officials, have still a lack of awareness among the public about the need to preserve and maintain the cleanliness of the area around the dam. If the public is conscious of the need to keep the area around the dam, of course, a nuisance problem does not occur. The dam became the focus of anglers also have reasons. Anglers make the dam as well, because almost all the rivers in the state have been contaminated or have changed the nature of the natural environment of the river due to the effects of urbanization. Fishing instinct and human needs, especially urban residents who want to have peace and relax the mind with recreational activities. Furthermore, the lack of recreational areas in the city, making the city the population was naturally find the nearest recreational area. Beside of sustainable land use control in the area around the dam, the Selangor government also is required to deal with the lack of recreational areas that occur in most townships in Selangor to avoid the public start make nuisance in the dam water catchment area. Conclusion of his actions to be taken by the Malaysian government are to establish the safety of the dam and In regards Selangor state level shall comply with the policies and sustainable dam management as a preset by the World Commission on Dam

CHAPTER 7: CONCLUSION

7.1 Introduction

This chapter will highlight the objective of this research have been archived and to highlight the knowledge that was generated from this study and the contribution of this study to help to achieve the Sustainable Dam Management Systems in Selangor. The contribution of this study will be discuss by refer the for main research objective. 1st is The Main Characteristics Of Dams In Selangor, 2nd The Issues in The Selangor Dam Basins, 3rd The Existing Dam Management Systems In Selangor, which involved the challenges and the evaluation of existing dam management system and 4th The Sustainable Dam Management System Model For Selangor. At the last of discussion this study will highlight the Sustainable Dam Management System Framework for all theoretical model and final model of this research.

7.2 The Main Characteristics of Dams in Selangor

This study has found that the dams in Selangor are fully functioned as a water supply. Selangor is the fastest growing state in Malaysia. Population growth and the expansion of industrial and business demands, increase the demand for water supply. Focus of the dam development in Selangor is more on the goal of ensuring the continuity of water supply for the development. Since dams in Selangor not only serves to ensure water supply in Selangor, it is also responsible for supplying water to Kuala Lumpur area and also part of the Nilai development area in Negeri Sembilan. Dam in Selangor also consists of a large-scale dam with high levels of disaster risk. Most dam in Selangor is over the embankment types. Which is compatible with the type of physical factors and landform in Selangor. All dam information obtained in this study will be used as an inventory that will help in decision making and planning in the existing management dams in Selangor. The dam inventory is an important element in Dam Management Systems as recommended by World Commission on Dam.

7.3 The Issues in the Selangor Dam Basins

In the literature review process this study has found the new knowledge about the relationship between dam, human and environment. The relationship between human, the dam and the environment are associated relationship with each other. Previous study is more on the impact of dam development to the human and environment. In the engineering term, the issues in dam study is more on impact of environment to the dam such as earth quake, land slide, sediment, animals and plant. This study has found a new relationship direction between human, dam and environment that is the impact of human activities on the dam to fill the knowledge gaps in the relationship between human, dam and Environment. Human built a dam for they own needs by built the dam structure. Than the environment react with build dam structure and become a dam reservoir. That's shows human, dam and environment is the entities related to each other. Selangor Dam issues more on to the human activities and the impact of urban sprawl surrounding the Kuala Lumpur and Selangor area. The urbanization activities are started approaching the dam basin area with threats such as, illegal dumping, angler's, land clearing, and other's. Information related to the major issues faced by the Selangor dams, can help the existing Selangor dams management systems in to take mitigation measures and fix the things or practices in the management of the dams. Although the dams management system still manageable, but the control and prevention measures must be taken to avoid a threat to the safety of the dam structure, and also a water quality.

7.4 The Existing Dam Management Systems in Selangor

The existing dam management system in Selangor seems to have a lot of weaknesses. The main weaknesses, there have no act related to the dam safety. The existing guidelines are not enforceable under any act or laws. Have no research institute and professional board in dam safety. Other's challenges in existing dam management systems in Selangor is, weaknesses in enforcement, laws implementation, laws and regulation conflict in land used control in dam basin area, have no integration between related agencies, limited budget allocation issues, lack of expertise in dam management systems, lack of laws and regulation, guidelines, manual, strategic plan and the lack of public awareness. All information relating to the challenges in Selangor dam management systems can help identify the weaknesses and the opportunities for improvement in the existing Selangor dam management systems. In the contribution of knowledge, this study has identified that the Selangor need a lot experts in the field of dam management, Establish the inter agencies or committee that are authorized under laws concerning the safety of the dam, which was approved in parliament, establish the institute of dam research and development, to provide and doing a research in dam management to prepare the Act, Laws, Regulations, Guidelines, Strategic Plan etc. all, for continuously improvements.

Toward sustainable dam management system in Selangor, this study has create the Selangor Dam Management Effectiveness Tracking Tool (SDMETT) to evaluate the effectiveness of existing dam management system in Selangor. This tool are inspired from a management effectiveness tracking tool for protected area frameworks by IUCN. The indicators in SDMETT used are still referring to the framework provided by the IUCN is adjusted according to the needs and nature of the dam and the surrounding area. As a result, Selangor Dam Management System is in category of "Sound Manage" which mean at the medium level. This result shows the sign that Selangor state need more improvement in Dam Management Systems. This study hope, Selangor Dam Management Effectiveness Tracking Tool (SDMETT) can help clubs the state to assess the efficiency of existing dam management systems. It can also be taken as a benchmark or indicator to ensure that the existing management system improved and reached the high level of effectiveness toward a sustainable dam management systems for Selangor. This tool can be used not only for the Selangor, but it can also be used in assessing the effectiveness of the management of dams elsewhere. Whether at another state or country. However, this tool could be improved and the indicator can also be changed to suit the administration or management system of a state, country or organization. Selangor Dam Management Effectiveness Tracking Tool (SDMETT) has been modified to suit the management system of dams in Selangor. And it can be uses as an evaluation tool for all policy, guideline and any measures in dam management systems in Selangor.

7.5 The Sustainable Dam Management System Model for Selangor (Policy)

Water Resources Development are becoming a challenging management target because of the increasing urbanization, industrial and infrastructural development and settlement growth associated with accelerated population growth. In the context of Malaysia, Selangor recorded as the highest number population size total in 2010 (5.386 million) is equivalent to 18.3% of the total Population (29 464 million). the population of the State is estimated to reach 9.0 million in 2035 with an average annual growth rate (AAGR) 2.0%. Projection population in the area Petaling, Hulu Langat and Klang approaching saturation level of development as reported in the Review of the Selangor Structure Plan, 2020 see table 7.1.

Table 7. 1 : Projection Population State 2010-2035 - Distribution Base Regions (In '000 People)

District	2010	2015	2020	2025	2030	2035	AAGR (%)
Sabak Bernam	105.8	119.2	137.6	167.6	207.8	225.0	3.0
Kuala Selangor	209.6	236.2	268.3	304.7	340.8	369.0	2.3
Hulu Selangor	198.1	223.3	275.2	327.5	382.4	414.0	2.9
Gombak	682.2	768.8	942.6	1,127.3	1,271.8	1,377.1	2.8
Hulu Langat	1,156.6	1,303.4	1,431.2	1,553.9	1,662.5	1,800.2	1.8
Petaling	1,812.6	2,042.8	2,091.7	2,201.3	2,335.8	2,529.2	1.3
Klang	861.2	970.5	1,073.4	1,142.6	1,188.7	1,287.1	1.6
Kuala Langat	224.6	253.2	323.4	373.2	423.9	459.0	2.9
Sepang	211.4	238.2	337.2	418.9	498.7	540.0	3.8
Jumlah	**5,462.1**	**6,155.6**	**6,880.6**	**7,617.0**	**8,312.5**	**9,000.8**	**2.0**

Resources: Review of the Selangor Structure Plan, 2020

Apart from the increase in population, which contributes to increased water demand, The increase in industrial areas also contributed to the high demand for water for industrial activities. Refered to Table 3.6, the land area for industrial activity is expected to be increase to 19.561 hectares in 2020 and 24,291.00 hectares in 2035. In period 2010-2035, an additional area of industrial land to be provided is 8,003.80 hectares. The main challenge for the preparation of industrial areas is provide a strategic industry with infrastructure facilities, particularly water supply.

Table 7.2 : Projections Industrial Land Requirements Future State Pages 2010-2035

District	2010	2015	2020	2025	2030	2035	Additional Requirements (%)
Sabak Bernam	95.60	117.30	143.30	172.00	206.50	247.80	152.20
Kuala Selangor	383.20	465.00	571.30	685.60	822.70	987.20	604.00
Hulu Selangor	1,340.40	1,680.40	2,198.80	2,238.80	2,666.40	2,800.00	1,459.60
Gombak	1,715.70	1,800.70	1,890.70	1,984.50	2,083.70	2,187.90	472.20
Hulu Langat	2,842.00	2,984.10	3,133.30	3,289.90	3,454.40	3,627.10	785.10
Petaling	5,549.10	5,715.60	5,882.10	6,048.60	6,215.10	6,381.60	832.50
Klang	2,645.30	2,881.90	3,116.90	3,351.90	3,586.90	3,821.90	1,176.60
Kuala Langat	1,078.40	1,318.60	1,621.20	1,945.40	2,293.50	2,504.40	1,426.00
Sepang	638.30	792.90	1,003.40	1,204.00	1,444.90	1,733.90	1,095.60
Jumlah	16,288.00	17,756.50	19,561.00	20,920.70	22,774.10	24,291.80	8,003.80

Resources: Review of the Selangor Structure Plan, 2020

To solve the problem in the management of water supply in the future, the SWOC analysis was conducted in this study to identify, the strength, weaknesses, opportunities and constrains in existing Selangor dam management systems to develop and propose the sustainable dam management systems model for Selangor. SWOC analysis as a result Selangor need to take an action regarding to the laws, guideline improvement and enforcement, strategic plan, land use control, involve and corporate with all related agencies and lastly is gain and increase the public awareness about the dam basin and water resources conservation. This study provides a model systematizing all components needed for a Sustainable Dam Management Systems (SDMS) that were generally lacking in past approaches in Selangor, and the SWOC analysis provide a medium for Selangor Sustainable Dam Management Systems Model (SSDMS) be implemented.

SWOC analysis on this study has developed the Sustainable Dam Management System Selangor Policy. There have 7 main strategies, (1) Gaining Public Acceptance; (2) Comprehensive Options Assessment; (3) Addressing Existing Dams; (4) Sustaining Rivers and Livelihoods; (5) Recognizing Entitlements and Sharing Benefits; (6) Ensuring Compliance, and (7) Sharing Rivers for Peace Development and security.

In Gaining Public Acceptance, Selangor State should implement the program to promote, educate and invite the public especially the target group such as a urban community that near the dam basin area, which are often visit the dam basin area ini Selangor.

Under Comprehensive Options Assessment, Existing Dam Management System in Selangor must use the Selangor Dam Management Effectiveness Tracking Tool (SDMETT) to help the state to assess the efficiency of existing dam management systems. It can also be taken as a benchmark or indicator to ensure that the existing management system improved and reached the high level of effectiveness towards a sustainable dam management system in Selangor. This tool could be improved and the indicator can also be changed to suit the administration or management system of a state, country or organization. Selangor Dam Management Effectiveness Tracking Tool (SDMETT) has been modified to suit the management system of dams in Selangor. And it can be uses as an evaluation tool and Key Performance Indicator for all policy, guideline, agencies and any measures in dam management systems in Selangor.

Addressing Existing Dams can be done with the dam inventory. Selangor State has an strength in term of Dam Inventory because of small amount of the dam in Selangor. Selangor already has a comprehensive dam inventory data, which included the type, function, disaster class, size, water level, water demand, population and area served and others. For value added in Selangor existing dam inventory, Selangor should include the information about the rainfall, maintenance, sedimentation and water quality monitoring, land use, and activity in the dam basin area. to look the relation and impact of activity and the land use in the dam basin to the water quality, sedimentation and others threats to the dam basin and dam structure.

Under the sustaining Rivers and livelihoods strategies, Selangor should take into account the threats of urban sprawl development to the dam basin area. major issues in Selangor dam is related to the human activities and impact from urban sprawl surrounding the Kuala Lumpur and Selangor Area. The urbanization in Selangor is started approaching the dam basin area. Dam basin also vulnerable to the land use conflict, and others threat such as illegal dumping, angler, land clearing, and other's. Selangor also has to control the activities within the dam basin area by enforcement. In term of land use control, Selangor State should compliance the National Physical Plan 3 (NPP 3) which has state the dam basin area as a environmental sensitive area. Any infrastructure, accept the dam structure are not allowed in the dam basin area. Agriculture, mining and timber also are not allowed.

Towards a sustainable dam management system in Selangor, Alternative water resources must be identify and implement in order to make sure the continuity of water supply for the future. Selangor has implement the three alternative water resources program. 1st is HORAS, 2nd is Ground Water Resources and 3rd is Interstate Water Transfer.

In Recognizing Entitlements and Sharing Benefits, The dam management system in Selangor is needs more improvement in terms of coordination of the implementation of the laws and regulations between the agencies involved. This adjustment can be taken by creating a new act relating to dam safety should be consulted and executed by all the relevant agencies and led by the National Security Council. The new act should explain clearly the role of each agency in the safety of the dam and watershed conservation. Which by this act of all agencies in the conduct these safety programs and maintenance of watersheds in the implementation of the act in accordance with their duties.

The dam management system in Selangor, already have some regulation related to the dam basin area control of activities. But there still have an error during the implementation and enforcement. In order to ensuring the compliance of laws and regulation related to the dam basin area and structure maintenance, Special Act on Dam Safety must be establish control controls and monitor all the agencies involve. Second task that Selangor has to enhance and enforce the existing guidelines under the Act related to the dam safety to ensure the compliance.

In Sharing River for Peace Development and Security, Selangor State should collaborate with others agencies from all level, such as Stake Holder, Dam Owner's, Dam operator etc all. The use and management of resources increasingly becomes the subject of agreement between States to promote mutual self-interest for regional cooperation and peaceful collaboration. This leads to a shift in focus from the narrow approach of allocating a finite resource to the sharing of rivers and their associated benefits in which States are innovative in defining the scope of issues for discussion.

7.6 Sustainable Dam Management System Framework for Selangor

From the research objective and the working model key word, this study has create a framework for implementation of sustainable dam management system in Selangor. Figure 5.1 shows the sustainable dam management system framework for Selangor state. This framework has five main element in dam management cycle. it's begin with the understanding of the dam characteristic and the basin area. Second is identifying an issues related to dam structure, dam water, basin area, human and environmental. Third element is identify the existing dam management system structure and challenges. 4th element is to evaluate the existing dam management system with the Selangor Dam Management Effectives Evaluation Tracking Tool (SDMEETT). Last element is to provide the appropriate Sustainable Dam Management System Policy for Selangor. After a few years of implementation of policy, the process will start back at the 1st element about the dam inventory. This process are continuously, it is start from identify the dam, issues, challenges, evaluation and policy.

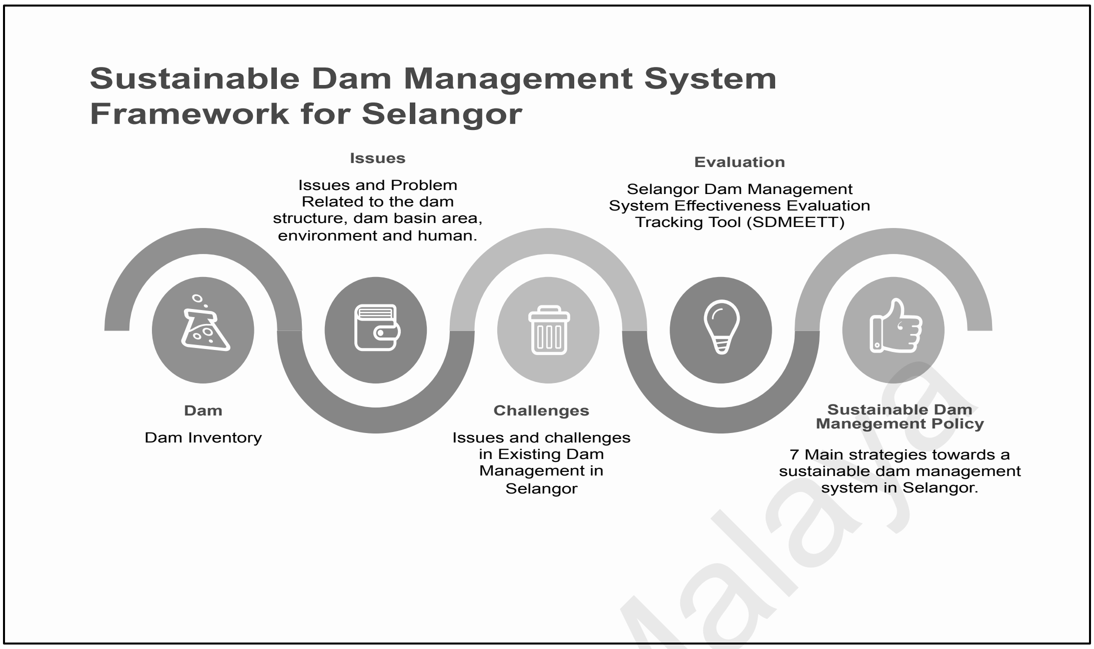


Figure 7. 1: Sustainable Dam Management System Framework for Selangor

7.7 Conclusions

From an overall view, can be conclude that Selangor dam are facing a new issues which, the city spread to close to the dam basin area. Without a control the activities from the city population in the dam basin area, will harm the water resources in the dam reservoir. Selangor is the fastest growing state in Malaysia. The rapid development will lead a conflict between the urban development and the preservation of water resources. Urban sprawl, not only approaching the dam, even urban activities or civilians from a nearby town who makes the dam basin area as a recreation area, will have an impact on the distribution of activities that could threaten dam basin area and also a source of clean water supply. This situation cannot be tolerated and it requires immediate action. However, to ensure the security and continuity of the dam and water supply, the state government also faces challenges in terms of the problems encountered in the existing management system. This research has generated information on the characteristics of the dam in Selangor, identify issues that occur in the basin of the dam, the issues and challenges faced in the existing dam management, the effectiveness of the management system of dams in Selangor and develop a sustainable dam management systems model for Selangor. This research has introduced the Selangor Dam Management Effectiveness Tracking Tool (SDMETT) to evaluate the existing Selangor dam management systems. Meanwhile SWOC analysis has list the strength, weaknesses, opportunities and constrains in existing Selangor dam management systems to develop provides a model systematizing all components needed for a Sustainable Dam Management Systems (SDMS) that were generally lacking in past approaches in Selangor. The recommendation for improvements in Selangor and Malaysia dam management systems is the government should provide special act pertaining to the safety of the dam to coordinate the roles and functions of the departments and agencies involved. And implement programs to comply with the policies on sustainable dam management system as suggested by the World Commission On Dam. However, at the state level, Selangor state government may take measures short-term planning, with adjusts the implementation of land use planning and control of the agencies involved. The first step is the SWMA shall cooperate with the local authorities involved amending the zoning of the dam catchment area through the local plan alteration. Where, the SWMA shall submit a written application along with plans gazette water catchment area of the dam to the local authorities engaged in the alteration zoning in the Local Plan. Local plan involved is the Selayang Municipal Council Local Plan, Ampang Jaya Municipal Council Local Plan, Hulu Selangor District Council Local Plan, Shah Alam City Council Local Plan and Kajang Municipal Council Local Plan. Accordingly, the district authorities involved shall make alterations according to the provisions of the Town and Country Planning Act 1976 (ACT 172). The second step is a long-term measure which the state government should provide financial allocation for the acquisition of privately owned land in the catchment area of the dam. And in the future there will be no timber licenses and other licenses, issued mileage in the catchment area of the dam. Since the opening of the dam catchment forest will reveal dams to sedimentation problems. Sedimentation will limit the ability of a dam load of water and can lead to flooding and the possibility of catastrophic dam break. The next, is public road or street which is close to the dam water body shall be limited to only the operator and have closed to the public because when a review of the available path provided in the area near the dam as such as Sungai Tua Road at Batu Dam, Sungai Tekali Road and Sungai Panjang Road at Semenyih Dam is actually a path that was cut shot and split the jungle and it conflicts with the policy of the Central Forest Spine as stipulated in the National Physical Plan. With respect to the road should not exist or move to an area that is quite far from the dam body and if possible cannot cross the dam catchment area. For a while, as public awareness of the preservation of the dam is low, the public must be prevented from approaching the dam catchment area, until the implementation of public awareness programs on the preservation of water catchment areas of the dam as it is recommended by the world commission on dam successfully implemented and effective.

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