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.
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 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](image)

### 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 Emergency Management Agency, 2004) see Table 2.1: Dam Hazard Classification.

### Table 2.1: Dam Hazard Classification

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


#### 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. First 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 research, 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 \((H \leq 4 \, \text{m})\) 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 $4-7 \times 10^6$ m$^3$ 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.
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 (<63μm). 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 inputs for 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 highlight 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-1. 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.
CONCEPT

Relationships Between Dam, Human Being And The Environment

- Build
- Water Supply
- Energy
- Recreation
- Flood
- Mitigation
- Reservoir
- Start
- Impact
- Resettlement
- Social Impact
- Economic
- Income
- Dam Failure / Burst / Hazard
- Flood
- Water Shortage
- River System Changes
- Ecology
- Fish Block
- Green House Gas Admission
- Breed Vector Diseases
- Urban Development
- Land Use Conflict
- Development
- Agricultural
- Land Clearing
- Green House Gasses Admission
- Urban Development
- Ecomonic
- Social Impact
- Resettlement
- Impact
- Earth Quake
- Sedimentation
- Weather
- Climate Change
- Wind
- Animal & Plant
- Earthquake

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 m$^2$ (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.
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.

![Diagram](image)

**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,

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 as 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

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

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.
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. 1\textsuperscript{st} is detailed site-level, 2\textsuperscript{nd} quicker site-level and 3\textsuperscript{rd} 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).
Figure 2.12: Use of World Conservation Protected Areas (WCPA) Evaluating Effectiveness Across the World.

Based on the response of 75 users (from White and Ofir, 2004).
There are 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.

![Diagram of management cycle](image)

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

<table>
<thead>
<tr>
<th>Elements of evaluation</th>
<th>Explanation</th>
<th>Criteria that are assessed</th>
<th>Focus of evaluation</th>
</tr>
</thead>
</table>
| 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: World 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

<table>
<thead>
<tr>
<th>Methodology</th>
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<tbody>
<tr>
<td>Rapid Assessment and Prioritization of Protected Area Management</td>
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<tr>
<td>Management Effectiveness Tracking Tool</td>
</tr>
<tr>
<td>New South Wales State of Parks (Australia)</td>
</tr>
<tr>
<td>Monitoring Important Bird Areas</td>
</tr>
<tr>
<td>PROARCA/CAPAS scorecard evaluation</td>
</tr>
<tr>
<td>TNC Parks in Peril Site Consolidation Scorecard</td>
</tr>
<tr>
<td>Victoria's State of Parks</td>
</tr>
<tr>
<td>AEMAPPS: PAME with Social Participation-Colombia</td>
</tr>
<tr>
<td>Parks profiles</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAPPAM</td>
</tr>
<tr>
<td>METT</td>
</tr>
<tr>
<td>NSW SOP</td>
</tr>
<tr>
<td>BirdLife</td>
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<tr>
<td>PROARCA/CAPAS</td>
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<tr>
<td>PiP SCSC</td>
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<tr>
<td>Victorian SOP</td>
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<td>AEMAPPS</td>
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<td>Parks profiles</td>
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</table>

<table>
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<tr>
<th>No. of assessment with the methodology</th>
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<tbody>
<tr>
<td>939</td>
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<tr>
<td>865</td>
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<tr>
<td>639</td>
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<td>102</td>
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<tr>
<td>89</td>
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<tr>
<td>62</td>
</tr>
</tbody>
</table>

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).
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 discussion. 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 discussed 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 into three levels. It’s High, Significant and Low level. The dam size category is divided into 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).
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.