

The Application of Check Dams Construction to Watershed Management: A case study in the North of Thailand

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ABSTRACT

A check dam is the structure that lay across the stream in the area of the origin of the stream. It is construction in rural communities as they help in the replenishment of water resources and restore moisture to the local ecosystem and benefit the environment. Check dams can be used to modify the velocity of stream flows, reduce erosion and also traps amounts of channel sediment, and help stabilize channel side-slope. This study illustrated for identify the application of check dams in creek streams. The application of reactively simple check dams were evaluated for gully control as part of watershed management implemented in Phrae Thailand. There are have 2 styles of check dam often used in Phrae Thailand. First, Temporary check dam are usually used with local material such as stone, log, or lumber, sandbag, or net. Second, Semi-permanent and permanent check dams are constructed by strengthen concrete of steel. The policy to spread check dams is feasible and great benefits are attached for the local people.

(Keyword: Check dams construction, Temporary, Semi-permanent, Permanent, Thailand)

Introduction

Problems of water resource management are becoming increasingly severe in most countries of the developing world. Thailand as many countries in

the world is damaged by big floods in rainy season and lack of water in other seasons. Since the end of the 1970s, the rapid development of Thailand has brought into focus the needs for integrated resourcemanagement as a basis for overcoming increasingly severe problems of drought and food

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(Nawarat K. and Adrian A., 1998). Watershed areas nowadays are facing serious threats due to over exploitation of the uplands. Over utilization of forest products and unwise systems of farming have been the major causes of forest clearing and degradation of upland watersheds.

Though, there are many factors causing problems on water resources such as amount of rainfall and rainfall intensity, land use abuse (particularly on the mountainous sloping lands), infrastructure including buildings, road network with careless of drainage systems, and waste water from industrial, domestic use and services, and agricultural practices. The upstream watershed deterioration affects the downstream water resources. “It is evidence that forest, land use practices, and water are closely related within watershed ecosystem. Since ecosystems are the source of water and life. Some ecosystems such as cloud forests provide clean water directly, and forest recharge our groundwater, which can be used elsewhere for drinking water or irrigation” (Bos and Bergkamp, 2001).

Check-dam system design has to fulfill several purposes (Fang, 1995):

1. To prevent flooding i.e. to ensure the checkdam system can withstand rainstorms.
2. To guarantee harvest from the dam farmland i.e. to reduce the loss of crops due to rainstorms.
3. To conserve floodwater and sediment by impounding.

4. To ensure that increase in height and repair of the dams after prolonged use are unnecessary.

In Thailand, despite intense interest in this issue, little systematic research efforts have been encouraged, resulting in scant evidence which is not free from confounding factors and speculation, based on some theoretical reasoning and statistical analysis. Bunkert (1973) believed that when large areas of forests are encroached, the balance of nature can be altered, and natural phenomena in the forms of flood and drought frequently occur. Similarly, Tangkitjavisuth (1979) said that forest encroachment in northeastern Thailand can cause drought, as was recently seen in wild temperature fluctuations and frequent flooding in this region (Pricillo G. Barrameda, 2008).

H.M. King Bhumiphol of Thailand has originated check dams as private project ecological concerns and their impact on the conservation of the environment. His Majesty had realized the importance of forests in preserving water, especially watershed which is the most essential factor in the forest. Our king has offered the most useful tool to conserve the forest, it is a Check Dam. Thus, the check-dam construction is important and well-known project to keep moisture for a forest, for the water resource, to conserve soil and water and also could build a check dam for agriculture. For the resource of the river a tree that grows around the area it's very important because it can keep moisture for a forest, for the water resource it could built a check dam for keep water for agriculture. In his majesty the king's thought the

way of check dam's construction has an objective to resurrection the forest and keeps water for agriculture.

A Check Dam is the construction that lay across the stream in the area of the origin of the stream. It can slow down the movement of the water when it has a heavy rain in the rainy season or when the storm is coming. A check dam can prevent or slow down the movement of a mud too and conserve a soil in the forest. The main purpose of check dams is to reduce water velocity and to trap sediments in gullies and streams instead of additional soil material being eroded away (Gray and Leiser 1982). They are used to reduce the velocity of concentrated flow and, therefore, to reduce the erosion in a swale or channel. Check dams should be used when a swale or channel will be used for a short time and therefore it is not feasible or practical to line the channel or implement flow control BMPs (Delaware DNREC, 1989).

In 2006, on the 80th birthday celebration of our King, Thai people will cooperate to build check dams as a contribution for the king. 80,000 check dams are planned nationwide, comprising small-permanent concrete check dams, and semi-permanent check dams constructed using local materials. The district aims to celebrate this occasion by jointly constructing check dams in cooperation with the Royal Project. The H.M. King Bhumiphol of Thailand, realized the importance of a forest in reserving water, especially watershed which is the most necessity of every factor in the forest. In his majesty the king's thought the way of check dam's

construction has an objective to resurrection the forest and keeps water for agriculture.

This paper illustrates check dams at the headwaters areas in Phrae Thailand. The objectives were to evaluate the application of check dams for gully control as part of watershed management implemented in Phrae Thailand. This study also reviews various approaches that have been taken to environmental services management and the political context from which they emerged.

Principle of Check-dam construction in Thailand

A small dam is constructed across an influent, intermittent drainage way only to reduce channel erosion by restricting flow velocity. Check dams are not meant for live streams. There can serve as emergency or temporary measures in small eroding channels that will be filling or permanently stabilized at a later date, such as in a construction setting. Check dams can also serve as permanent measures that will sediment in over time in gullies, which is a more common usage in range and agricultural settings. By constructing a series of check dams along the gully, a stream channel of comparatively steep slope or gradient is replaced by a stair-stepped channel consisting of a succession of gently slopes with "cushioned" cascades in between (Gray and Leiser, 1982). A structure designed to reduce channel grade in natural or constructed watercourses to prevent erosion of a channel that results from excessive

grade in the channel bed or artificially increased channel flows. This practice is used to stop head cut erosion or stabilize gully erosion. Grade stabilization structures be vertical drop structures, concrete or riprap chutes, gabions, or pipe drop structures (Smolen et al., 1988).

Check dams are the royal observation theory of development and restoration forest by resources useful purpose that affords relations the most benefit for wildlife, forest and community. His Majesty the King's was realizing about forest importance. Water is necessary in a live forest. His Majesty the King's was submitting material to useful for conservation and reforestation by check dams. Check dams are constructing across the river normally they across source of the stream or steep area for obstruct sediment. Check dams can support while moving when to be overflow and the stream have subsided. It was support soil and water conservation.

On his majesty the king, the form of check dam will have a low cost by construct it with natural resources in this area such as stones that cover it with a nest to block a stream and a small river in the length. It can protect a damage of a ground and can preserve water from a drought also.

Teams are working on improvement of watershed areas through proper land use management and soil conservation practices in the already slashed and burned areas. They have successfully fulfilled His Majesty's wish by placing emphasis mainly on the hill tribe's

consciousness on the conservation of forest and watersheds has been motivated and better standard of living in the project areas has been conceived. It can slow down the movement of the water when it has a heavy rain in the rainy season or when the storm is coming.

The check dam in Headwater areas can be categorized into two groups, based on the purpose.

1. Temporary check dam (Figure 1)

Temporary check dams are one of the water pollution control practices for sediment control. It can be constructed in a short time by natural material of stone, log, or lumber, sandbag, or net. The construction sites usually at first order stream or water channel, which can slow down water flow and increase the moisture around that area. Total cost of one check dams possibly are 140-150 US\$ (Pradap, 2005). In addition this method has save the costs sometime no cost at all only the labor. The maximum height of temporary check dams is about one meter. These special material constructions normally can last 3-5 years.

Temporary check dams can build with many materials. For example

- 1.1 Construction with a timber, flanked by stone
- 1.2 Construction with a timber, flanked with clay or sand bags.
- 1.3 Construction with soil compression core flanked by stone

1.4 Construction with a structure of sort with stone.

1.5 Construction with a ridgeConstruction with bamboo by personal intelligence.



Figure 1. Temporary check dam construction

2. Semi - permanent and Permanent check dams (Figure 2, 3)

These practices has constructed by strengthen concrete of steel. Total cost of one check dams possibly are 715-1,430 US\$ (Pradap, 2005). The area construction should be second or third order; not over 5 meters wide. These practices had keep water, also have subsided or depressed and often wet stretch of land in dry season. There can be used where it is impossible to otherwise divert flow and stabilize the channel. The order of streams where these check dams built are at head second or third order stream.

The selection of check dam construction area

1. To consider in purpose of check dam construction, this was support the objective of check dam construction. For example to storage water, to prevent and slow down the movement of sediment and water.
2. Physical geology of the stream. Utai (2007) explained the suitable on position of check dam have enhanced follow with the decrease of slope of water channel (Figure 4). A number of products manufactured
3. specifically for use as check dams are also being used, and some of these products can be removed and reused. There are supports for the physical features of the land
4. Topography of stream. Check dams can be constructed of natural material, and have the advantage of a longer lifespan when heavy rainy season. Inspect for sediment buildup behind the check dam and signs of erosion around the check dam after each rain.



Figure 2. Semi - permanent check dams construction



Figure 3. Permanent check dams construction

Remove sediments when depth reaches one-third of the check dam height.

5. Land use and land cover which area is suitable for each check dam. Temporary check dams (Figure 5) also can be constructed downward and narrow slope stream (Utai, 2007). Semi-permanent check dams and Permanent check dams should be constructed profound pedestal to bedrock. It have trap and pull groundwater over check dams. The material constructed of logs or lumber, have the advantage of a longer lifespan, and should be carefully to use especially logs.
6. The community has encouraged and participate project. So, the villagers can understand how important and benefits of forest in providing food, housing material as well as conservation of lands and water resources.

Most of the samples check dams do not follow strict rules for water allocation. The

construction of check-dams in Thailand has ensured the availability of irrigation water during summer. Water starts receding in the check dams from the tail ends, thus reducing the temporal availability of water from check dams to tail-ends. Building of check-dams, which creates conflicts between the beneficiaries of check dams, is the major issue confronted in the management of check dams. The upstream check dams are constructed to water availability for downstream check dams is greatly increased. Downstream check dams must bear more water pressure as water flow is increased due to the confluence of more tributaries when a stream reaches the farthest end.

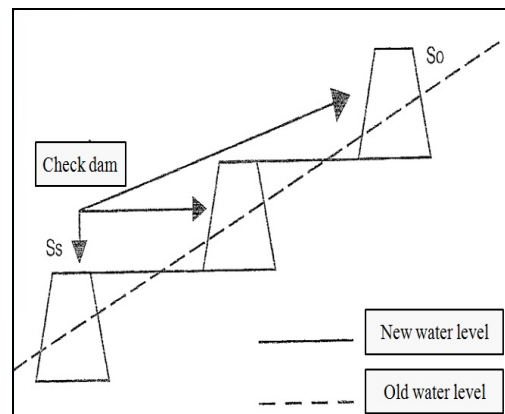


Figure 4. The position of check dams

Study sites

The study area on this case is Doiluang Wildlife Sanctuary of Huaymai Sub-district, Song District, Phrae Province, which was aimed to study the check dams construction. Doiluang

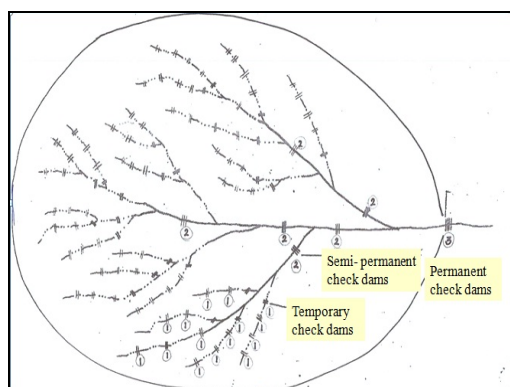


Figure 5. The check dams construction layout in a watershed area in Thailand

Wildlife Sanctuary (Figure 6) was established on October 1, 1984, when forests were regarded as sufficiently abundant for people to cut or collect timber or forest products freely for their own uses or for commercial purposes. They hope to conserve the forest and protect area for wildlife. In 1989 the Government abrogates on the working of the forests.

Now they were come to get subsist goods such as fuel wood, herbs, and wood for building, rope, bush meat, fodder, mushrooms, honey, edible leaves, roots, and fruits. Indirect benefits such as land for other uses, social and spiritual sites, environmental services, including watershed protection and biodiversity conservation. The climate of the study area is North of Thailand, with the rainy season. Though, the plant communities are well known in the Doiluang Mountains.

Benefits of check dam

construction at Doiluang wildlifesanctuary

The construction of check dams in this area has ensured the availability of storage water during summer. The most important benefits are keep moisture and to useful for conservation and reforestation. The upstream check dams are greatly increased by constructed to water availability for downstream. These areas are protected or conservation forest which must be strictly permanently as head water sources. Check dam be absorb and slow down the speed of water to sediment retention. In addition, awareness and information on natural resources management are introduced to local communities.

These study areas have four parts of watershed (Figure 7), Huaymai watershed, Huaypao watershed, Huaychun watershed, and Maetoom watershed. The climate of the study area is North of Thailand, with the dry season. Though, the plant communities are well known in the Doiluang Mountains. In each area have each reservoir. Huaymai watershed has Huaymai reservoir, Huaypao watershed has Huaypao reservoir, Huaychun watershed has Huaychun reservoir, and Maetoom watershed has Maetoom reservoir. At 2008 Doiluang wildlife sanctuary have build check dam construction of 4 watershed areas, show at table 1.

Check dam construction procedures are the same as a common building, but the process of construction and work control has easier to create than building. Construction works are

generally conducted by themselves and using local labor. The check dams' position had been decided by carefully considered which the decision based on elevation, topography, road and stream network, slope, watershed, and water bodies. The 4,400 check dam with 4 areas should be constructed on DoiLuang Wildlife Sanctuary,

which covered area 60,625 ha. From the field survey checked and confirmed the positions of

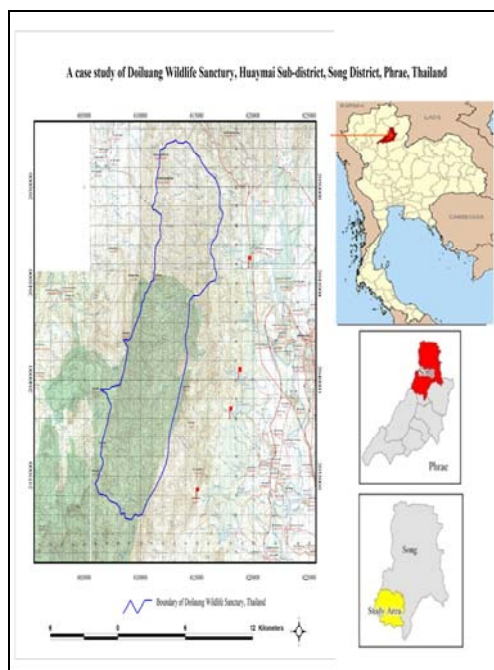


Figure 6. The study area

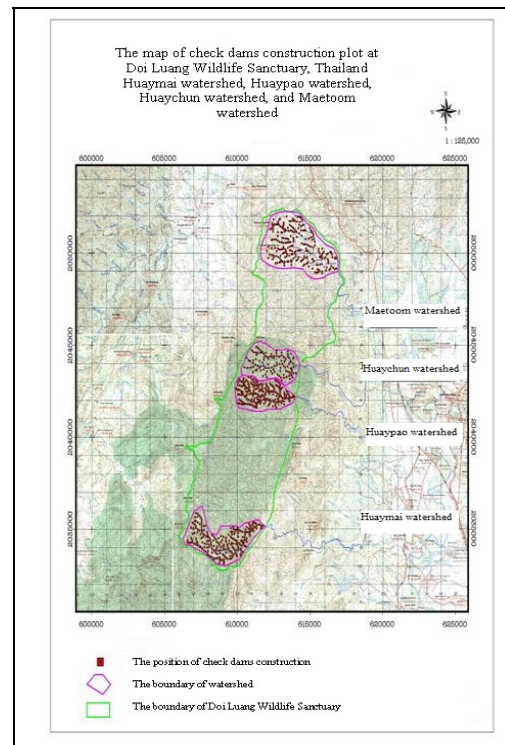


Figure 7. The construction of check dams at DoiLuang Wildlife Sanctuary, Thailand
Source: (Doiluang wildlife sanctuary, 2008)

Table 1. The information of check dam construction at Doiluang wildlife sanctuary, Thailand, 2008

Site	Temporary check dam	Semi-permanent check dam	Permanent check dam
Huaymai watershed	1,500	4	2
Huaypao watershed	700	3	-
Huaychun watershed	700	3	-
Maetoom watershed	1,500	5	-

Source: (Doiluang wildlife sanctuary, 2008)

check dam by using GPS. The example of check dam construction showed in figure 8.



Figure 8. Example of check dam construction at Doiluang Wildlife Sanctuary, Thailand

Check dams also serve to slow the movement of water, allowing increased percolation into the soil. Just above a check dam is a good place to put in a percolation structure. Silt that builds up behind the dam creates good farmland, which can be planted after the rains while it retains moisture. The following series of pictures show one farmer's success with building a percolation tank just upstream of a series of check-dams. Thus, Check dam construction design has to fulfill several beneficial:

1. Check dams can reduce the velocity of concentrated water flows and erosion of the channels and also traps small amounts of sediment generated. Source of river has lengthen and more quantity.

2. They have more species diversity relate to the variety of animals, plants and micro-organisms in any particular area. They also lead to succession diversity or the natural process of succession by plant communities especially in forest ecosystems.
3. Bringing maximum water supply to the cultivated areas enabling the crop cultivation to take place twice a year during the rainy season and the dry season. It is aquatic animal inhabitation.
4. Providing fish supply for the farmers, that is, when a reservoir is constructed, fish fry will be released to be food or source of supplementary income for the farmers in the nearby villages.
5. Providing moisture in the soil, allowing the forests to stay green throughout the year and establishing 'wet fire break' which forms a protective strip against forest fires all over the watershed areas. In dry season they have decrease strength of fire.

The watershed classification would be modified according to the community needs but should not exceed its carrying capacity. The forest in the headwater source was denuded, reforestation for soil and water conservation must be undertaken to reduce soil erosion and improve the ecological environment. Although, watershed classification was initiated for the purpose of watershed-ecosystem conservation, it consequences in long term will contribute to the better quality of stream water for downstream people as well as other environmental condition.

Downstream water resources developments in the future are expected to gain the benefit from this project if it could be effectively implemented throughout the country. Remove soil and rock together to create a little water to the detention of water. The help slow down the flow of rain water will go down to the stream so quickly that do not take advantage. The check dam will store water, slowing the branded water. A remove bamboo the wood is easy to find a crater in the jungle. The check dam system in gullies is the most effective measure to control sediment pouring into the watershed at Doiluang Wildlife Sanctuary.

Summary and Conclusions

The government considers the combination of watershed areas and the communities occupying these to be the components necessary for integration of the planning process and subsequent plan implementation. The experience from these demonstration watershed management action planning exercises will be evaluated and if successful, will be applied to environment and resources management in other watersheds around the country. In a small watershed, various dams can be built, such as productive dams for forming farmland, flood-control dams for preventing floodwater and intercepting sediments, and water-storage dams for irrigation.

There are many strategies have been carried out to cope these problems. Protection and rehabilitation of watershed ecosystems

incorporate with participatory land use planning is an important strategy for sustainable forest management and water resources conservation including mitigation of floods and droughts, and water quality within a watershed context (Tangtham, 1996). In Thailand, as already noted above, deforestation and water shortages have become major environmental concerns in recent years. These areas require special soil conservation and protection measures, and where forest should be replanted or permanent agro-forestry should be practiced (Nawarat and Adrian, 1998).

Check dams in Thailand as originated from His Majesty the King's private study. The form of check dam will have a low cost by construct it with natural resources in this area such as stones that cover it with a nest to block a stream and a small river in the length. There offer low material costs as well as ease of installation costs if materials are readily available. It can protect a damage of a ground and can preserve water from a drought also. A water can percolate around this area, it will make this area has a moisture enough in dry season and it will protect this area from a wildfire and a plants can grow easily and the trees do not shed leaves, the forest will has a green shady. The most effective way to conserve soil and water in Thailand is to construct check dam systems. It can slow down the movement of the water when it has a heavy rain in the rainy season or when the storm is coming and prevent or conserve a soil in the forest. The policy to spread check dams is feasible and great benefits are attached for the

local people. This will be beneficial in formulating policy on forest resource management in the future.

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水土保持學報 43(1) : 111 – 122 (2011)
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99 年 11 月 16 日收稿
100 年 01 月 18 日修改
100 年 01 月 24 日接受