

## Relationships Among Biophysical Characteristics Of Catchment, Land Use And Management Affecting Flood Probleme, Of Huay Mae Bon Basin Mae Ta Sub-District, Mae On District, Chiangmai Province

ความสัมพันธ์ของลักษณะชีวกายภาพพื้นที่รับน้ำ การใช้ที่ดินและการจัดการที่มีผลต่อ  
ปัญหาน้ำท่วมของกลุ่มน้ำห้วยแม่บอน ตำบลแม่ทา อำเภอแม่ออน จังหวัดเชียงใหม่

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### Abstract

The study aimed 1) to analyze the relationship of biophysical characteristics of catchment area, irrigation system, land use and management that affected flood problem of Huay Mae Bon River Basin, Mae Ta Sub-district, Mae On District, Chiang Mai Province, and 2) to study the potential and limitation of flood management of related sectors including both local organization and government sector to support problem solving and holistic integrated management. The study used 1) survey data on physical characteristics of upper catchment area, irrigation system, land-use pattern and management for data analysis, and 2) data on in-depth interview with community leader and related sectors for content analysis through interdisciplinary approach that integrated survey research with statistical data on inflow/outflow and average rainfall as well as mapping data. The result showed that flood in Huay Mae Bon River Basin was a result of two main factors causing repetitive problem. Although four factors related to the problem, biophysical characteristics of catchment area did not affect flood problem and irrigation system properly helped mitigating flood. Thus, the main cause of flood problem was land use because land use pattern of most farmers invaded public area on both sides of riverbank for making paddy because population growth increased demand for more cultivation area, which the land use pattern obstructed water flow and narrowed water channel that caused river flood into agricultural area. Another main cause of

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flood was the separated problem management among all sectors that lacked database connection for solving flood problem together, which it caused flood problems. Therefore, holistic approach should be used for integrating all sectors to solve flood problem together by using data on biophysical characteristics of catchment area and irrigation system as a foundation of data analysis as well as using data on land use pattern and management for solving the problem together to get effective solution and create non-partitioned operation as in the past, which the approach can potentially mitigate and effectively solve flood problem to enhance sustainability further.

An objective of this article is to study the effects of biological characteristics of irrigated areas, irrigation systems, land use and repeatedly flooding management of Huay Mae Bon water groups. To analyze the potential and limitations of the agencies involved in the solution of flooding problems In order to find a way to prevent flooding sustainably.

#### บทคัดย่อ

การวิจัยนี้มีวัตถุประสงค์เพื่อ 1) ศึกษาวิเคราะห์ความสัมพันธ์ด้านลักษณะชีวกายภาพของพื้นที่รับน้ำระบบชลประทาน การใช้ที่ดิน และการจัดการ ที่มีผลต่อปัญหาน้ำท่วมของลุ่มน้ำห้วยแม่บอน ตำบลแม่ทาอำเภอมะเอน จังหวัดเชียงใหม่ 2) เพื่อศึกษาศักยภาพและข้อจำกัดของการจัดการปัญหาอุทกภัยน้ำท่วมของหน่วยงานที่เกี่ยวข้องทั้ง องค์การชุมชน และหน่วยงานของทางภาครัฐ เพื่อนำไปสู่การจัดการปัญหาและการจัดการแบบองค์รวมเชิงบูรณาการ งานวิจัยเล่มนี้ผู้วิจัยได้นำข้อมูลที่ใช้ประกอบด้วย 1) ข้อมูลจากการสำรวจเชิงกายภาพของพื้นที่รับน้ำตอนบน ระบบชลประทาน รูปแบบการใช้ที่ดิน และการจัดการ มาเป็นฐานในการวิเคราะห์ข้อมูล 2) ข้อมูลจากการสัมภาษณ์เชิงลึกจากผู้นำชุมชนและหน่วยงานที่เกี่ยวข้องเพื่อทำการวิเคราะห์เนื้อหาเกี่ยวกับการศึกษาวิจัยแบบผสมผสานใช้วิธีการศึกษาเชิงสหสาขาวิชาระหว่างการวิจัยเชิงสำรวจกับการผสมระหว่างข้อมูลทางสถิติซึ่งการคำนวณปริมาณน้ำเข้าและ น้ำออก ข้อมูลสถิติทางจากปริมาณน้ำฝนเฉลี่ยโดยอาศัยข้อมูลเชิงแผนที่ประกอบการวิเคราะห์ จากการศึกษากรณีน้ำท่วมในพื้นที่ลุ่มน้ำห้วยแม่บอนเกิดจากปัจจัยสำคัญอยู่ 2 ประการที่เป็นสาเหตุของปัญหาเชิงซ้อนปัญหาใหญ่ก็คือ ผลการศึกษาพบว่าความสัมพันธ์ทั้ง 4 ด้านที่เป็นมูลเหตุของปัญหา มีความสัมพันธ์เกี่ยวเนื่องกันในด้านลักษณะชีวกายภาพพื้นที่รับน้ำ

ไม่มีผลต่อการเกิดปัญหาอุทกภัยน้ำท่วม ด้านชลประทานสามารถช่วยบรรเทาปัญหาอุทกภัยน้ำท่วมได้ดีในระดับหนึ่ง แต่ประเด็นที่เป็นสาเหตุสำคัญของการเกิดปัญหาอุทกภัยน้ำท่วมกลับอยู่ที่ ด้านการใช้ที่ดิน ทั้งนี้เพราะรูปแบบการใช้ที่ดินของเกษตรกรส่วนใหญ่มีการรुक้าพื้นที่สาธารณะที่ถูกกันไว้ทั้งสองข้างลำน้ำโดยใช้พื้นที่ดังกล่าวเป็นพื้นที่นาเพราะการขยายตัวทางด้านจำนวนประชากรที่เพิ่มมากขึ้นส่งผลให้มีความต้องการใช้พื้นที่ทำกินเพิ่มมากขึ้น ซึ่งการใช้ที่ดินในลักษณะดังกล่าวเป็นการกีดขวางการไหลของน้ำ ทำให้ลำน้ำมีสภาพแคบ น้ำไหลไม่สะดวกจึงล้นเข้าสู่แปลงเกษตร สาเหตุอีกประการก็คือการจัดการปัญหาของทุกกลุ่มองค์กรมีการแยกส่วนในการแก้ไขปัญหา ขาดการเชื่อมโยงส่งถ่ายข้อมูลอันเป็นข้อมูลพื้นฐานที่นำไปสู่การแก้ไขปัญหาอุทกภัยน้ำท่วม

ร่วมกันทำให้ด้านการจัดการก็มีส่วนที่ก่อให้เกิดปัญหาอุทกภัยน้ำท่วม จึงอาจกล่าวได้ว่า แนวคิดการแก้ปัญหาการเกิดอุทกภัยน้ำท่วมที่มีการเชื่อมโยงข้อมูลแบบองค์รวมมาบูรณาการการทำงานร่วมกันโดยอาศัยข้อมูลจากลักษณะทางกายภาพของพื้นที่รับน้ำ ระบบชลประทาน มาเป็นฐานในการวิเคราะห์ข้อมูลโดยมีการศึกษารูปแบบการใช้ที่ดินและการจัดการมาเป็นข้อมูลที่เชื่อมโยงแก้ไขปัญหาร่วมกันนำมาซึ่งแนวทางแก้ไขปัญหามีประสิทธิภาพ ก่อให้เกิดแนวทางการปฏิบัติไม่ทำงานแยกส่วนเหมือนที่ผ่านมา ปัญหาอุทกภัยน้ำท่วมที่มีก็จะบรรเทาลงและถูกแก้ไขได้อย่างมีประสิทธิภาพก่อให้เกิดความยั่งยืนต่อไปในอนาคต

## Introduction

Repeated flood events have caused loss of properties and agricultural products in Huay Mae Bon River Basin for a long time as a chronic problem. Flood was previously a result of over 80mm of rainfall for 3-day duration (Tha Neau Royal Project, 2014), which it is a flash flood that rapidly dried within three hours by draining to Mae Ta Stream. Heavy rain caused four flood events each month killing agricultural plantation repeatedly. Nowadays, flood events still occur but the frequency is varied each year and it is caused by dam overflow.

Huay Mae Bon River Basin is small area at altitude of 1200 meters above sea level and slope 60 degree supporting people in Ban Tha Kham, Ban Koh Klang, Ban Huay Sai and Ban Pa Not, Mae Ta Sub-district, for agricultural activities and water supply (Akasing, 2005). Nine tributaries in Huay Mae Bon catchment area flow down forming v-shaped drainage and enter the main stream at right angle because the area is on Mae Ta fault (Department of Mineral Resources, 2015). Water infiltrates through soil with v-shaped cracks and then returns to the surface. Catchment area located in granite mountain, so flooding problem. The study provides a new academic knowledge via a practice on minor watersheds area with overlapping problems but separated problem management. Furthermore, the literature review reveals most of related researches were the description of flooding problems such as a relationship of rainfall to hydrological problems (Chankaew, 2008), flooding management by large irrigation system, usage of land in the upstream-midstream-downstream area (Siriudom, 2008), and agricultural land use that causes flooding problems. However, none of these researches have been describe or study on complete causes of the problem apart from several studies of partial causes.

The repeated flooding in Huai Mae Bon basin might be caused by 4 factors involving separated management and a lack of study of physical causes in related watershed area. In order to solve the flooding problem (Kasem Chankaew, 2008), suggested that the management requires a complete aspect of crucial factors, including physical characteristics, irrigation systems, land use, and integral management. The study of these factors should not be

separated or study only one aspect of the problem. Ultimately, this research extended concept of compete study for 4 factors and determined whether the factors are the root problems or not.

### **Objectives**

The research determines objectives for 2 main issues as following:

- 1) To analyze biophysical factors, the catchment area, irrigation system, land use, and management, and the flooding problems in community of Huay Mae Bon River Basin, Mae Ta Sub-district, Mae On District, Chiang Mai Province.
- 2) To study the potential and limitation of flooding management by agencies, community organizations, and communities that is relevance to holistic problems in order to contribute problem management and integrated management.

### **Rationale and Literature Review**

The author reviewed relevant research literatures, including various theoretical concepts, used as a database in the analysis and understanding of the flooding problems in the basin area of Huai Mae Bon. The understanding of watershed ecological concepts, ecological concept in biophysical characteristics, and relationship between rainwater catchment areas and hydrology are needed to relate the factor of the flooding problems. In addition, theory of irrigation engineering management (water catchment areas with crisis of flooding problems and concept related to irrigation management), concept and theory about land use (land use that causes flooding problems, changes of land use concepts, natural resource management concept, and co-management), and sustainable development (concept and practice that focus on holistic cause and integral flooding management) are considered as important factor as well.

A construction of conceptual framework for the understanding of realistic spatial phenomena should emphasize on physical characteristics, which are geological structures that affect decomposition and soil formation, including moisture and elevation characteristic of the area, related to the flooding problem. The emphasis can be done by collect contributing factors for biological characteristic of forest structure as one of the variables linked to the flood problem. Furthermore, the study of rainfall behavior, which is an uncontrollable factor, could indicate characteristic of water flow on the upper water catchment area.

This research demonstrated whether pattern of irrigation system, which are the catchment building structure and capacity potential of the catchment, contribute or prevent flooding problems. The conceptual theory was brought for in-depth perspective of problems. The study was divided into 4 aspects; biophysical characteristic, irrigation systems, land use, and management under the holistic-problem perspective. In-depth problem analysis was performed for each issue, including the understanding of separated problem-solving that might cause repeated flooding problems.

Most of researches on flooding problems have been conducted in separated contents and focused only on problem solving at the end result and conducted specific analysis in regardless of an integration of catchment area as an indicator. Kasem Chankaew (2008) studied the basic principles of integrated water resource management and found a faulty analysis of flooding problems came from water management error with an incomplete aspect of problem analysis. According to flooding management, the first factor was a suitable area characteristic for water catchment, soil is in good condition, able to control land usage, including abundant of watershed forest and high potential to support the water. The second factor involved a planning of catchment area management, which is well irrigation system with reservoirs to slow speed of water flow down, or detention basin (monkey cheek area) for protection and drainage. The third factor was a suitable land use in regard of area and land condition. Consequently, the fourth factor was flooding management in accordance with integration model of water management to successfully operate flooding issues. Therefore, the empirical research of flooding problems is rare. Most researches focus on a management of flooding problems in accordance with the study by Sirapachara Watcharapasakorn (2013) about the management of flooding problems and participation of community in the case study of Laemthong Athletes Village, Saphan Sung District, Bangkok. The study suggested that the guidelines for solving flooding problems in the community of Laemthong athletes village can be implemented by construction policies, consisted of transportation route improvement, water drainage improvement, water pump installation in the community, and construction of water protection line around the community, and by management policies, consisted of knowledge providing for house and property protection to avoid or mitigate the effects of flood, dredging the drain to unclog waterway, release remaining water out of drain system during the rainy season to prepare for rainfall, providing of transportation service during flood, and pool transportation for community residents. Kampi Krampim (2001) studied the management of flooding problems in the Bangkok. The researcher suggested that flooding

problems caused by a lack of well management. The inconsistent management with the expansion of urban communities and flooding management by each administrative area caused conflict issues in a neighborhood. The researcher proposed a guideline management for flooding problems in manner of an entire watershed area instead of each of administrative area. People involvement in the management should be promoted in order to meet their actual needs by laws support and clear regulation of operation authority. In addition, the researcher also proposed policies related to flooding problems that should be focus on civilian relief rather than full protection because the relief policy will lessen an impact on environmental than the preventive measure of construction. Accordingly, both academic content and research divided the issue into separate sections. Therefore, this study embed the theoretical conceptual on an understanding of problem linkage by defining the physical characteristic, irrigation system, land use, and management. The empirical data was used to present the phenomena of flooding problems linked by nature model, to understand the potential and mechanisms of databases accessing, and to identifying elements under holistic integration. This study is a distinctive work of problem solving on the core that can be applied in the management of flooding problems for watershed area elsewhere.

However, the context of diverse locations would encounter diverse of problems in accordance with the potential and limitation of each area, different culture and customs, and organization culture, including diverse way of life and ethnicity, leadership in the operation and management, different natural resources, and potential and limitations of the budget policy. All of these contexts affect the variation of flooding problems regardless of the potential of the area. The aspect of holistic problem integration would contribute the successful and efficient of problem solving.

The concept of integrated holistic theory is a new concept that study on a realistic of all things under the integration principle, which is to correlate and link in everything. The holistic element integration is generally addressed as a novel and difficult concept to understand. This theory is often used along with the relationship of integration. The holistic concept is used to solve problems and develop society. Although the theoretical principle is recognized, the understanding of problems is still difficult reach to root problem. In England, theoretical concept of the word “holistic” was addressed as a separated concept under a certain state (Asian Development Bank, 2014).

This theoretical concept was used in the study of the flooding problem in Huay Mae Bon basin where has been repeatedly flood for many years. The integrated holistic concept highlights on a perspective of holistic problem from a small part to the widest part. In case of the flooding problem of the Huai Mae Bon basin, the holistic approach considered from the water catchment area upward to irrigation system including land use by community affecting the flood problem or not and connect to the issue management. This process would reveal a solution of the root problem that was once hidden by the overlooked condition with the information that was unable to reach the root cause of problem in the past. However, the integration is an important part used to link aspects with the holistic problem as a realistic element leading to the linked management. The author was interested in the concept of holistic approach together with integration in the study of new theoretical concept which was applied to a case of flooding problems, henceforth.

The finding of root problem analyzed by an integrated holistic approach in the study area revealed hereafter;

The issue was likely “short in the dark” that unable to solve the flooding problem right on the point. Therefore, the concept and practice of holistic cause as a theoretical concept that manages separated problems using integrated concepts. The holistic causes study in all aspects related to flooding problems whether it is biophysical, land use, or management data to complete the elements of water resource management without missing any information. Moreover, scientific information, for example, aerial photograph map, and geographic information map from satellite etc., and another empirical data used along with the map which are history and conditions of land use and natural resources in the area that were surveyed by stakeholders would allow the researcher to understand the facts of the ecological sensitivity of resource base status. The rights under the legitimacy of villagers and communities will be brought to bargain (based on facts) and build a mutual recognition with a common goal of united living of people and forest that should provide a solution guideline sustainably.

### **Methodology**

Mixed method study was used through interdisciplinary data including statistical data on annual rainfall and annual inflow/outflow. Rainfall in the years before and after reservoir construction was compared for distinct difference of flood stage. The causes of flood problem were separated into four issues: 1) biophysical characteristics of upper catchment area, 2) irrigation system of Huay Mae Bon River Basin, 3) land-use pattern, and 4) problem management. Data analysis relied on mapping data and in-depth interview with community

leader and government sectors (Royal Irrigation Department and Mae Ta Subdistrict Administrative Organization) about the year with the most severe flood, annual devastating effects and government assistance.

Research tools included the map of physical characteristics of Huay Mae Bon catchment area and soil quality meter. Four years (2014-2017) of on-site survey to collect data on physical characteristics of upper catchment area, irrigation system, land use and management pattern. The data were analyzed the cause of flood problem to support process on searching proper problem-solving guideline. Study area covered Huay Mae Bon River Basin including agricultural area depending on Huay Mae Bon that located in Ban Koh Klang, Ban Tha Kham, Ban Huay Sai and Ban Mai Don Chai covering the area of 2,354 rai and 2,753 people in Mae Ta Sub-district, Mae On District, Chiang Mai Province.

## Results

Results of study on relationship of biophysical characteristics of catchment area, irrigation system, land use and management that affected flood problem of Huay Mae Bon basin, Mae Ta Sub-district, Mae On District, Chiang Mai Province were separated into four areas for more research understanding as below. The issue of the hydrology problem of the Huay Mae Bon basin was analyzed as the major causes of flood problem to provide guidance and find solutions to achieve sustainability as well as to completely eliminate flood problem in the future or mitigate flood magnitude.

6.2.1. Biophysical characteristics of the Huay Mae Bon basin that is headwater forest – the study found that Huay Mae Bon headwater forest was catchment area and in good condition. Although the area had not high biodiversity, mixed deciduous forest with bamboo can properly absorb water. In addition, granite structure with low sedimentation because of suitable tree canopy can support and reduce the intensity of rain before falling to the ground. Shrubs also densely covered all over forest ground. Soil characteristics were also suitable for plant growth creating stable basin ecology. Therefore, this aspect did not relate to flood problem in any way because the index of the catchment area said that the area had the potential to prevent soil erosion and soil surface collapse.

6.2.2 Irrigation system – structure of reservoir supported topography of the area that provided good water-holding capacity. In addition, the reservoir was in quite perfect condition and had low sediment with water storage capacity of 2.1 million cubic meters. Since the upper catchment area was in good condition, it did not cause any sediment increase. Therefore, sediment that drained into reservoir was low. In addition, stream had high water velocity and



small shrubs and ground-cover plants can trap sediment before entering into the reservoir. Thus, the reservoir can hold water at the same level as original design of water storage capacity. In this point, the study only found that cause of flood problem was spillway overflow that flooded agricultural area. Huay Mae Bon basin had water cost of 10,930,180 cubic meters and available water of 4,134,350 cubic meters, which the reservoir can hold 2.1 million cubic meter of water with the highest water storage level of 2.7 meter and drainage rate of 94.44  $\text{m}^3/\text{s}$  or 8,246,295.21  $\text{m}^3/\text{day}$ , so the water volume caused overflow was 8,246,295.21 cubic meters, If average rainfall in Huay Mae Bon basin was higher than 90 mm/day. Rainfall of 120 mm in August caused over 2.1 million cubic meters of water volume in reservoir, which over 2.7 meter of water level caused flood over agricultural area. But, water storage and reservoir structure did not affected flood problem. In this regard, flood problem was affected by spillway overflow draining into agricultural area because of misuse of land that obstructed waterflow and drainage channel, which it cause repetitive flood in agricultural area.

6.2.3. The study found that the issue of land use affected the repetitive occurrence of flood problems in the Huay Mae Bon basin because the water flowed into the spillway with riverbank preserved as public area for 6 meters each side (total public space of 12 meters). If in reality the amount of water that exceeds the capacity of the reservoir overflows over the spillway into the river, the public area will not be flooded because the mass of water will be in a protected area only for public space, but with the use of community land with limited land space combining with the expansion of the community from population growth. Thus, the public are were changed into new paddy field for the survival of the household population. In this regard, it resulted in the river squeezed to become smaller. In addition, in the use of land, plants such as bamboo were grown on both sides of the river causing the water to not flow easily. When this factor caused repeated flooding problems in the Huai Mae Bon Basin area, a solution is established by dredging the area of the river, making the weir to reduce the severity of water, making tunnels and waterways but the solution to this problem reinforced the problem of flooding to more severe because of sediment and rock from dredging river that builds into a water barrier were flushed with water current into paddy fields. Water flow blows the sandstone soil into the rice fields of the villagers. When the water recedes, drilling is performed doing new rice fields like this every year. In the middle of solving complex problems, focusing on solving at the end of the cause was mostly unsustainable because they do not know what the real problem is. Therefore, the flooding problem of the Huai Mae Bon Basin affected by misuse of land causing repetitive flood event

6.2.4. Former management of flood problem by Department of Water Resources, Mae Tar Subdistrict Administration Organization including community organizations and people in the community have participated in some level of problem solving but still cannot solve this problem. This may be due to the lack of connection and understanding of non-integrated problems, which both sides think different sides but this management problem has some impact on the occurrence of flooding problems as being the second issue after land use problem. If all sectors bring information to analyze the situation to solve the problem together, the researchers believe that they will be able to find a way to solve this flood problem in a sustainable and objective manner. It can be said that the flooding problem of the Huay Mae Bon Basin area was caused by the misuse of land. However, context in different areas affected different problems depending on the potential and the limitations of the area. Every area faced with a problem that may not be the same with custom culture. Culture of organization group, lifestyle, leadership in the preparation and management of natural resources, including the potential and limitations of the budget policy may not be the same for all of the above. All of these will definitely result in flooding absolutely different. Regardless of the potential of the area, if looking at the problem of holistic integration, it will lead to success. In solving problems that are effective in accordance with the research of Boonjong Khaosithiwong (1996) that analyzed the causes and problems of the water crisis management of Thai society with the important topics as sewage crisis drought or shortage and the flood crisis. The cause of the flood came from the lack of water storage area. In addition, forests that are like natural dams for Bangkok that is the lower area of the Chao Phraya River, in the area of influence of the sea causing both the sea water support problems and the northern water running down. When combined with the problem of land collapse, Bangkok have a chance to face the flooding problem that can be prevented by water source development to support water water diversion and drainage)

Therefore, the most important thing is cooperation, whether government and private, groups or community organizations that have a role to be able to jointly propose guidelines and policies that benefit the community and housing. Studies have shown that the root cause of the problem is not the physical environment at all. On the other hand, humans are an important factor that underlines chronic problems for a long time. However, if all parties cooperate to solve the problems together, all problems will be resolved in a good way. From the case study of the hydrological problems of the Huai Mae Bon Basin, it is a sample case that analyzes the root cause of the problem in detail until having a clear conclusion

leading to a solution that will complete the components of the research procedures and processes. In this regard, the cause of the problems over the past several decades has not been linked information to solve the situation because in the present condition, the community is expanding because of the increasing population. But the case in this area is the use of arable land is still the public area. However, when studying the problems that arise amid cooperation and connect information without data that limited the analysis of the situation, analysis from the root cause one by one inevitably gets powerful information.

Previous research for flood problems mostly conducted in separate researches. The study focuses on solving problems at the end of the cause and conducting specific analysis without mentioning the integration of the receiving water area as an indicator. Therefore, this research has put the theoretical concepts to understand the linked problems by classifying into the physical characteristics, irrigation systems, land use and management and making as empirical data that can understand the phenomenon of flood problems that is naturally linked understanding on the potential and mechanism of accessing the database and distinguishing the elements under the holistic integration. This research is distinct and prominent in solving the problem on the spot and be applied to manage flood problems in other watersheds.

## Discussion

The study on biophysical characteristics of upper catchment area, irrigation system, land use and management showed that the most influential factor was improper land-use pattern of local people. In the past, forest concession introduced flood problem, which later reforestation and reservoir construction can decrease flood intensity. Public area on riverside was more changed into paddy field that was exacerbated by river trespass because of smaller water channel. In addition, inconsistent dam maintenance caused flow obstruction by weeds. Incorrect method of sediment removal by government sector and local organization also worsened flood problem. This end-around solution as hasty problem-solving did not directly deal with real cause of problem because it did not base on the fact of problem. Thus, previous solution created negative effects more than benefits. Specially, current population growth in area limitation exacerbates improper land use.

Self-reliance was strength of people in Mae Ta Sub-district, which they tried to monopoly resource management under limitation of area context. Trespass in other areas, such as utilization and conservation forests, was absent and trespass area on riverside was still determined as public area. Therefore, flood problem in Huay Mae Bon River Basin may

increase severity of problem if management will not analyze problem together with the local context to balance nature and environment.

Physical environment slightly affected flood problem, whereas human was main factor of chronic problem. Cooperation among all sectors to solve problem may introduce good result. Case study on Huai Mae Bon's flood problem showed the detailed cause analysis to clearly summarize the complete solution guideline including procedure and process. Lack of data connection in problem-solving process for many decades caused unsuccessful solution. Case study area showed effects of population growth and land use, which the trespass area still was public area. The study found actual obstacles, which cooperation and sufficient data for analyzing real situation and actual causes will help getting effective solution.

### **Suggestions**

In this regard, the researcher suggested that the integrated holistic problem should be studied about flooding problems in other areas with a similar context to the Huai Mae Bon Basin because the similar physical area can analyze the problem according to the community context and cause to maximize benefits of sustainable flood solutions in the future.

In addition, small river basins should be studied by using the same analytical principles as this research in order to be a way to solve the flood problem that has the potential to solve the problems that meet the points and to maximize benefits of sustainable flooding problems in the future.

Separated management of flood solution in all areas did not occur only Huai Mae Bon Basin. We cannot solve the problem in just a short time but resolving problems in each area may spend different time based on situation of areas. If this situation arises, it is necessary to research and analyze the root cause of the problem. If the other area has a similar context to the Huai Mae Bon Basin, it can apply suggestions and solutions for solving problems. With various principles and reasons according to the study on analyzing the flood problem, it is quite difficult to solve the situation smoothly due to the limitations of time period, budget, way of life, customary and traditions of the area are different. The strength and unity of the community are important factors that will make the success solutions even rights of the solution are different. However, the concept of holistic integration is another concept that may cause solutions to various problems, not only the problem of flood management but also for other problems.

The researcher hopes that this research will more or less benefit other basins or other areas that are experiencing floods. If anything goes wrong, the researchers respectfully apologize. Any suggestions are welcome to use for developing the future research. Consistent with Kasem Chankaew's research (2554) which studies the basic principles of integrative water management, found that the analysis of flooding problems caused by water management mistake of responsible people who look at the problem not completely all sides. The point in flooding management found that, the first factor, the characteristics of water receiving area must be suitable with good soil condition and can control land use complementary with upstream forests must be perfect in condition and have the potential to accommodate water. The second factor that involved must have a plan management for the receiving area, which is a good irrigation system and a reservoir that can slow down the water speed or the Kaem Ling for water protection and drainage. The third factor is land use that is appropriate for the area condition. From three factors to the fourth factor, is the flooding management which uses the integrated water management model successfully to manage the flood problem. Therefore, the successful management of the flooding problems must connect the four relation sides, will solve specific problems not just one of them.

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