Project Reference Number: ARCP2012-05CMY-Zhen

Project Title

"Holistic Assessment of Land-Use Change and Impacts on Ecosystem Services of Wetlands"

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LIPI

BSMRAU

Global LAND Project

“Holistic Assessment of Land-Use Change and Impacts on Ecosystem Services of Wetlands”

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Final Report submitted to APN

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OVERVIEW OF PROJECT WORK AND OUTCOMES

Minimum 2pages (maximum 4 pages)

Non-technical summary

Wetland ecosystem in Asia plays a key role in providing necessary goods and services for humans and wild animals. With the rapid economic development and population growth, wetland ecosystem in Asian countries has been experiencing significant changes, it is therefore essential to assess such changes. This project attempts to investigate the impacts of land-use change on ecosystem services in three wetlands of international importance in China, Bangladesh and Indonesia. Assessment criteria, methods and techniques developed and used will contribute to technical capabilities of participation countries. The project will also provide information needed for wetland decision-making, and increase public awareness and young scientists' capability of wetland issues for sound management action. It has also established networks with APN, IHDP, GLP, IGBP, WFP, UNEP and national and international relevant networks, good research cooperation and exchange of APN's member countries has been established.

Keywords

Wetlands; ecosystem services; participatory approach; household; InVEST; APN member countries

Objectives

The main objectives of the project were:

- Provide answers both on methodological and theoretical level to tackle the tasks around sustainable use of land resources and ecosystem services;
- Develop assessment criteria, methods and techniques to contribute for technical capabilities of APN nations;
- Provide information needed for wetland decision-making, and increase public awareness of wetland issues for sound management action;
- Develop network with APN, GLP, WFP and national and international relevant networks;
- Strengthen research cooperation and exchange of the case study countries in particular, and APN in general.

Amount received and number years supported

The Grant awarded to this project was:

US$ 53,000 for Year 1:
US$ 37,000 for Year 2:

Activity undertaken

1. Reviews of existing land-use practices, problem description, document analysis, and stakeholder's interviews, to gather background data and information.
2. Conducted data collection in 3 wetlands in China, Bangladesh and Indonesia, using participatory rural appraisal, household survey, and key informant surveys. Besides, Statistics and maps were

gathered.
3. Assessed impact of land use change on ecosystem services using InVEST model approach and statistical analysis. Young scientists have attended training on the model use.
4. Expert consultations have been conducted for comments of the research progress and scenario development of land use changes.
5. Three workshops were held in China, Bangladesh and Indonesia for progress reporting, planning for the next years, and field surveys for better understanding of the research topics.
6. Participation in international conference to disseminate research findings and develop networks.
7. Interviewed by public medias and NGOs in Bangladesh to demonstrate the results and establish relations with those organizations.

Results

1. Developed evaluation methods for assessing impact of land-use change on ecosystem services
2. Established Decision Support Tool, which can be used as reference for land use policy making
3. Capacity building of young scientists and stakeholders in the study areas. About 10 young scientists including post-graduate students have been involved in the research activities and trainings for research methods, and several meetings were held in the survey sites, which are significant for improving their knowledge on ecosystem service and land use policy issues.
4. Networking. Research and collaboration network has been established among the research countries, GLP, IHDP, IGBP, WFP, IUCN and UNEP, as well as NGOs and local governments of the study countries. Relations with institutions in Germany (Leibniz Central for Agricultural Landscape Research, ZALF), UK (Oxford University) and Holland (Wageningen University) have been stressed.
5. Reporting and publications: Final report is prepared, and about nine journal papers are under review or published, which are important for dissemination of the findings.

Relevance to the APN Goals, Science Agenda and to Policy Processes

Land-use changes in the past have resulted in substantial net gains in human well-being and economic development, but also in the degradation of many ES, leading to increased vulnerability of livelihood, especially of the poor. The degradation of ES has accelerated in the last years and is threatened through ongoing global change processes. However, there is a dearth of research and appropriate techniques of linking land-use and ES changes. This project will provide answers both on the methodological and theoretical level to tackle the tasks around sustainable use of land resources and ES. Assessment criteria, methods and techniques to be developed will contribute to technical capabilities of APN nations; provide information needed for wetland decision-making, and increase public awareness of wetland issues for sound management action. The project will develop network with APN, IHDP, GLP, IGBP, WETLANDS and national and international relevant networks, and will strengthen research cooperation and exchange of China, Bangladesh and Indonesia in particular, and APN in general.

Self evaluation

In the study area of China, We had finished this project in line with the objectives and major contents in the proposal. Through literature review, field surveys and data analysis, we have understood the major land use/cover changes and their impact on biodiversity and soil retention in the past 20 years. The results have provided important information about how human activities such as land use policy and ecological restoration activities affect these ecosystem services in Poyang lake wetland of China. In addition, by applying InVEST model, we have simulated biodiversity change tendency in the future under the influence of different policy scenarios, the results will provide scientific basis and support for decision making.

In the study area of Indonesia, wetland ecosystem is the one of the essential ecosystem,

which needs to be protected and managed wisely. It is recorded very high flora biodiversity of the wetland in Indonesia and many of them are useful for the people surrounding this ecosystem. Most of people in this area use the natural resources for their household activity. The ecosystem give the services to the people, since the land use change into other purposes occur in this ecosystem, there were some changes in this ecosystem and need to be explored the reason and impact of the changes on the ecosystem to human activity and human wellbeing. Therefore through this research project, we were able to examine and evaluated the impact of the land use change in the wetland ecosystem and to do the ecosystem assessmen in the Giam Siak Biosphere Reserve. Giam Siak Biosphere Reserve is one of wetland ecosystem in Indonesia and has been declaired as the Biosphere Reserve on 2009. Unti now the analyses of social aspect of this area still limited. The results of this project give the important information about the ecosystem services and the discription of the study area. This information as the basic data for the stake holder to manage wetland ecosystem in Indonesia.

In the study area of Bangladesh, we have conducted the study as per designed schedules and interchanged views with regional partners through 3 workshops, e-mails and formal mails etc. and established an excellent relationship with the Chinese Academic Sciences, Beijing and Research Centre for Biology, Bogor, Indonesia. As an output of the project we prepared scientific report.

Potential for further work

In China, Poyang lake wetland provides important ecosystem services. In this study, we have evaluated land use change impact on biodiversity and soil and water conservation services in the past 20 years, as well as their future change scenarios. It is needed to conduct further studies on the impact of land use change on other services like provisioning services culture and landscape amenity, flood regulation, carbon sequestration, etc, also, it is important to explore how the households ultilize and consume wetland's services, people's awareness and capacity building on wetland conservation, as well as policy interventions to mitigate human's effect on the nature's ecosystem services. The results and data gained from this research will be useful for the future studies

In Indonesia, The ecosystem services assessment data has been describes in the study site, these data are the main information to managed Gam Siak Biosphere Reserve. The study would be continued for monitoring biodiversity and carbon sequestration in the wetland ecosystem.

In Bangladesh, A number of actions for future work have been listed for appropriate resources management of Tanguar haor and maintaining the livelihood of the communities. Among these, priority areas are: Intensive program for assessment of resources of the whole haor areas; Development of policy and techniques for conserving the natural resources for sustainable uses in view of both natural and anthropogenic threats; Awareness building program among the local people on the importance of resources and the ecosystem services for their livelihoods; Awareness creation initiatives among the people for protection of water from pollution; Step for dredging the rivers/ beels for maintaining water retention capacity and water flow/movement processes; Create alternate income generating opportunities such as 'ecotourism' to reduce the dependency of the people on haor wetland.

Publications

Sun Chuanzhun, Zhen lin, Wang Chao, Du Bingzhen, Hu Jie, 2014. Impact of ecological construction projects on Land use/cover change in Poyang lake area, Resource Sciences, under review.

Sun Chuanzhun , Zhen lin, Wang Cha, Du Bingzhen, Hu Jie, 2014. Biodiversity simulation of Poyang Lake wetlands by using InVEST model under different scenarios. Resource and Environment in the Yangtze Basin, under review.

Sun Chuanzhun, Zhen Lin, Wang Chao, Yan Bangyou, Cao Xiaochang, Wu Ruizi, 2013. Impacts of ecological restoration and human activities on habitat of overwintering migratory birds in the wetlands of Poyang Lake, wetlands, *J. of Mountain Science.* DOI: 10.1007/s11629-014-3128-8.

Chuanzhun Sun, Lin Zhen, Chao Wang, Bingzhen Du, Jie Hu, 2014. Impact assessment of land use change on ecosystem services in representative wetlands of developing countries. In proof reading.

Sun Chuanzhun, 2014. InVEST Model based impact assessment of Land Use Change On Biodiversity and Soil Conservation functions in Poyang Lake Wetlands. PhD thesis of Chinese Academy of Science, Beijing, China.

Vera B.L.S, M. Fathi Royyani, and Lin Zhen, 2014. The Land Use Changes and The Effects on provisioning Services for 32 Years in Temiang Village, Biosphere Reserves of Giam Siak-Riau. Preparation paper.

M. Fathi Royyani & Joeni Setijo Rahajoe, 2013. Behind The Sacred Tree: Local People and Their Natural Resources Sustainability, Reinwardtia. Accepted.

M. Fathi Royyani & Vera B.L.S-Local People, Biodiversity, and Ecosystem Services. Preparation papers.

Vera B.L.S, Bayu Arief Pratama. Laode Alhamd, and Joeni Setijo Rahajoe, 2013. The Land Use Change Effect in Anjir Pulang Pisau Village, Central Kalimantana. Reinwardtia. Accepted.

Md. Giashuddin Miah, Minhaz Ahmed and Tofayel Ahmed. Impact assessment of land-use change on ecosystem services of tanguar haor wetland, Bangladesh. Completed and waiting for proof reading.

Acknowledgments

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Thanks are also extended to the concerned personnel of local offices of Agricultural Extension, Fisheries, Water Development Board, Local Government Engineering Department, CEGIS, IUCN for kind cooperation providing information, maps and other supports.

TECHNICAL REPORT

Minimum 15-20 pages (excluding appendix)

Preface

Rapid economic development, population growth, urbanization and globalization have caused significant changes in land use and ecosystem services in developing countries. This cross country study, under financial support from APN, has addressed research questions of what are drivers of land-use change and how do they affect wetlands' delivery of ecosystem services? What management decision support tools are needed to protect ecosystem services? The research conducted natural resource and social surveys in selected wetlands in China, Bangladesh and Indonesia, ArcGIS & InVEST were applied for assessment; decision support tool is developed; capacity building and networking were made for enhancing future collaboration.

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1 Introduction

On a global scale, wetlands are one of the most valuable resources, providing a number of ecosystem services (ES), including biodiversity support, water quality improvement, flood abatement, and carbon management. The world's wetlands and rivers have felt the brunt of human impacts; in Asia alone, about 5000 km2 of wetland are lost annually to agriculture, dam construction, and other uses (Zedler & Kercher, 2005). Human's land management decisions may result in trade-offs in the delivery of different ecosystem services. Different types of land use and management can maintain or deplete ecosystem services and functions (Hagedorn 2008).

Lots of studies have focused on land use transitions and modelling (Verburg, 2006; Helming, 2008; Deng, 2008), multifunctional land use and impact assessment of land use changes (Mander, 2007; Sieber, 2008), interactions between land use and farming systems and individual ES (Helming, 2008), and valuation of the global and human well-being significant ES (Costanza, 1997, de Groot, 2007, MA, 2005). Relevant and most important knowledge gaps exist in the landscape and related evaluation, especially interactions and trade-offs between land use and ES.

Although most of ES are still recognized as "public goods", the policy makers have been kept uninformed about the status of ES as affected by the land use decisions. This problem becomes severe in wetland ecosystems, where most of the goods and services are provided and used by local people and wild species. This project will provide answers both on the methodological and theoretical level to tackle the tasks around impact of land use change on ES towards land use options.

2 Methodology

Explain how you carried out the project, which should follow logically from the aims. Depending on the kind of data, this section may contain subsections on experimental details, materials used, data collection/sources, analytical or statistical techniques employed, study field areas, etc. Provide sufficient detail for a technical/scientific audience to appreciate what you did. Include flowcharts, maps or tables if they aid clarity or brevity.

2.1 Detailed data collection methods

2.1.1 Poyang lake wetland in China

2.1.1.1. Data source and collection methods on major land use types and descriptions of each land use type

(1) First hand data collection method

We use the high resolution remote sensing (2.5m, date: June, 2010) as a reference to shape the land use/cover map of 3 typical villages for the year 2000 and 2012. We classified the land use and cover types based on the Chinese classified system which consist of 6 land use types, including forest, grassland, wetland, cultivated land, construction land and others. Cultivated means land for crop planning, frost means land for arbor, shrub, bamboo. Grassland means herbaceous plant which covers above 5%. Wetland means natural water body and herbaceous wetlands. Construction land means residents, mining site and transport land, other land means some unused land such as bare land, desert / sand, saline.

(2) Second hand data collection method

In Poyang Lake wetland site, we collect the land use/cover data (30m resolution ratio, the year 2000 and 2010) of the whole area of Poyang Lake wetland from the Institute of remote sensing and digital earth, Chinese Academy of Sciences.

2.1.1.2. Data collection method(s) on land use changes over past 20 years

Firstly, land use cover maps with different years can show land use changes over the past 20 years. Secondly, participatory rural appraisal (PRA), household questionnaire also show land use changes from different views. PRA method is used to preliminary understanding the overall land use change in this study site in the past 10 more years. In order to understand the land use change from the peasants' view, 125 household questionnaires are finished in 3 typical villages which are also field surveys villages.

2.1.1.3. Data collection method(s) on driving forces of land use changes over past 20 years

(1) First hand data collection method

Expert workshop was hold and discussing the driving forces of land use change. Further identify driving forces by take household questionnaire and by organize PRA. In order to find the reason and the main driving forces of land use change in Poyang Lake wetlands, 125 household questionnaires were finish in 3 villages. Questions are focus on what made land use change and why it was happened.

(2) Second hand data collection method

Some driving forces such as population increasing, economic increasing data and agricultural input data were collect from statistical yearbook or government document, or even from Literature study.

2.1.1.4 Data source and collection methods on major ecosystem services and descriptions of each ecosystem service

(1) First hand data collection method

PRA method was used to identify the main ecosystem service types in Poyang Lake wetlands. We hold 3 PRA in 3 village of this study site, 12-15 villagers had been invited in each village. Different occupation, age and gender were considered.

(2) Second hand data collection method

Expert meeting was hold in Dec, 2011, all the experts come from the 3 countries. With two days discussion, we preliminary know the main ecosystem services in each study site. And in Poyang Lake, we had read many literatures about the ecosystem services in this site. We had finished some project in that area, so we also have some second hand data such as soil map and migratory bird data.

2.1.1.5 Data collection method(s) on changes of major ecosystem services as affected by land use changes over past 20 years

(1) First hand data collection method

In Poyang Lake wetlands, Migratory bird habitat of two typical villages was shaped by field survey, which at the same time village land use/cover map was shaped, also take high resolution remote sensing as reference.

(2) Second hand data collection method

In Poyang Lake wetland site, we collect soil distribution data from resources and environment data center, Chinese academy of sciences. We collect migratory bird observation data from the local natural conservation administration. We collect the land use/cover data (the year 2000 and 2010) of the whole area of Poyang Lake wetland from the Institute of remote sensing and Digital Earth, Chinese academy of sciences. We collect the rainfall data from China meteorological science data sharing service. The DEM data (30m) comes from NASA Goddard Earth Sciences (GES) Data and Information Services Center (DISC). Some other data which need by InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs) model such as soil erodibility factor, management measures factor, and habitat stress source data were come from literature.

2.1.2 Giam Siak Biosphere Reserve in Indonesia

2.1.2.1. Data source and collection methods on major land use types and descriptions of each land use type

First hand data collection methods include the followings: Field work, Participatory mapping trough PRA, In depth interview: key informants.

Second hand data collection methods include the followings: Questionnaire distribution, Literature studies, Open ended interview.

Focus Group Discussion and questionnaire survey, interview, and literature studies methods were applied for land use change analysis, changes of key ecosystem services affected by the land use change over the past 20 years.

2.1.3 Tanguar haor in Bangladesh

2.1.3.1. Data source and collection methods on major land use types and descriptions of each land use type

The data sources for identification of land use types were the primary and secondary sources. The primary sources were the opinion of the respondents through face to face interview and group meeting and field observations. The secondary sources were the information/statistics collected from the local government and non-government offices. For primary data, three villages (Golabari, Hukumpur and Silon Tahirpur) at the close vicinity of Tanguar haor at Tahirpur Upazila under Sunamganj district were selected. There were 185 housholds in those three villages, among them 60 households having 20 households from each village were randomly selected and extensively studied through pre-tested interview schedules/questionnaires by face to face interview by the researchers. Five beels of haor at nearby villages were selected and monitored for primary information. For secondary information, researchers went to the respective government offices like agriculture, fisheries and water development board as well as non-government offices and collected relevant information.

The major land use types identified through these methods were: settlement with tree plantations, cropping (both single and double cropping), water bodies (beels and rivers), vegetation (swamp forest) and mudflat. Among those, the largest land use type was water bodies (29.5%) followed by single cropping (25.4%), mudflat (19%), settlement (12.8%) and vegetation /swamp forest (9.5%).

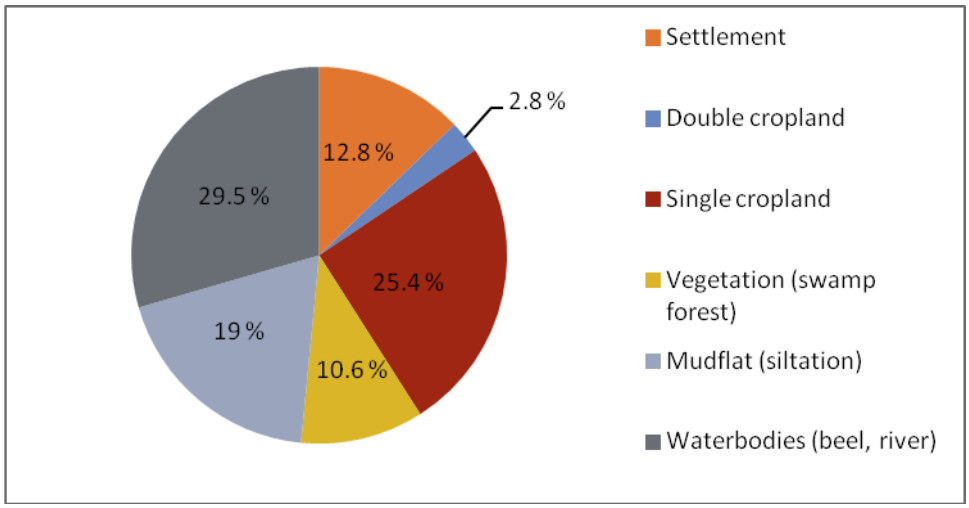


Figure 1 Major land use types in the study area

2.1.3.2. Data collection method(s) on land use changes over past 20 years

Data for land use changes over time were collected through informal and formal surveys and interviews to the respondents households; discussion meeting with the local experienced personnel, official records of the local government offices as well as analysis of the old (1989) and current satellite images. The informal survey was site visits, Rapid Rural Appraisal (RRA), and discussion with local experienced personnel. Several field/site visits and PRA were done to understand the overall land use change in the study area over time followed by formal face to face questionnaires survey and then Focus Group Discussion (FGD) to validate the information. The formal questionnaire survey was conducted on 60 households of three villages like identification of land use types.

The full map of Tanguar haor map (1:100000) was collected from Local Government Engineering Department (LGED) Ministry of Local Government, Bangladesh as well as high resolution remote sensing images were bought for the year 1989 and 2010 from the CEGIS as a reference to shape the land use/cover map of the study site as well as whole haor site and then analyzed the land use change over past 20 years using Arcgis tools. Then the findings were verified with field observations and discussion with the concerned local Departments.

2.1.3.3. Data collection method(s) on driving forces of land use changes over past 20 years

Focal Group Discussion followed by opinion of experienced local people was held to identify the driving forces of land use change. This information were enriched and confirmed through household questionnaire survey. Further refined of information was done through discussion with the concerned officials of the Upazila.

Some driving forces such as population increase, other demographic as well as economic data, agricultural input data were collect from statistical yearbook and from literature study. The long-term meteorological data (1961-2010) were collected from the nearby meteorological station. These data were analyzed to identify the climate variability and extreme events, and to verify the climate variability and events with the farmer experiences and perceptions.

2.1.3.4. Data source and collection methods on major ecosystem services and descriptions of each ecosystem service in your study site

PRA method was used to get first hand idea on the main ecosystem service types in Tanguar haor wetlands. This was done in three villages separately and then combined the information. The next step was individual face to face interview through open type questionnaire. The outcome of this information was combined with the PRA outcomes. Then FGDs were organized in three villages where 20-25 households in each villages contributed by providing their valuable opinions. A list of ecosystems was documented from review of literature of past reports on Tanguar haor and discussed and validated the information at local level experts. Through these separate intensive methods we have finalized the ecosystem services of the Tanguar haor wetland.

The major ecosystem services identified through PRA, survey, FGD and literature survey were: food, fuel wood, biodiversity (fish, bird, plant etc.), flood control, drinking/irrigation water, sedimentation retention etc.

The importance of each of the ecosystem services can be described as follows:

(1) Tanguar haor wetland has great importance in providing a range of ecosystem services. This wetland is the most important rice production (Boro rice) place during dry period (December to May) , while functioning as a back-water reservoir during the monsoon (rainy season). This is also the place for harvesting different edible aquatic vegetation and their products. Tangua haor is the unique source of fuel materials (cooking). Local people used to collect reeds, leafs, branches of trees from the swamp forest to cook their food.

(2) Tanguar haor is the unique place for fish production as it functions as a 'mother fishery' for the country (Ref), where parent fishes take shelter in the winter and in early monsoon in the grassland and rice field surrounding the haor and becomes their spawning ground. The fisheries resources of

the haor provide direct income to the local inhabitants as well as to the Government through earning revenue.

(3) Tanguar haor is very rich in biodiversity, providing both tangible and intangible services in the form of crop and fish production, maintenance of swamp forest, reeds etc. It is very rich in fish biodiversity along with other flora and fauna. Tanguar haor is said to have home of 141 varieties of fish, more than half of Bangladesh's 260 freshwater fish species. In addition, 11 amphibians, 34 reptiles, 206 bird species and 31 mammals are found in the area. During the winter months, thousands migratory water flows take shelter in this wetland. These indicate the importance of this haor in maintaining and strengthening biodiversity.

(4) This hoar is a large water reservoir areas between levees or banks of large river systems at the foothill of the Meghalayan-Joyanti hill i.e. water is available here round the year, but the most important fact is that water is used in dry season for irrigation and other domestic purposes. This also plays an important role in controlling flood during monsoon as water reservoir.

(5) Swamp forest is one of the most important land use type in Tanguar haor wetland. The forest possesses important soil sedimentation retention function.

2.1.3.5. Data collection method(s) on changes of major ecosystem services as affected by land use changes over past 20 years

The changes of major ecosystem services because of land use change over time were documented through both primary and secondary sources. The primary sources were respondents' opinion through survey and discussion meeting, and the secondary sources were IUCN (International Union for Conservation of Nature) documents and statistics of local government offices. The changes of local and migratory birds, fish resources and biodiversity, crops and cropping were collected from IUCN document, Department of Fisheries (local), and Department of Agriculture, respectively. The data for swamp forest was collected from the Local non-government offices and Department of Forestry.

2.2 Detailed data analysis methods

2.2.1. Poyang lake wetland in China

2.2.1.1. Detailed data analysis methods on land use change and driving forces

For land use/cover data in GIS format, Arcgis tools are used to analysis land use/cover change process and land use/cover conversions. The reasons for each land use change were analyzed using mostly descriptive method. Data and information from PRA were analyzed using qualitative description method. Data from household questionnaire were analyzed by SPSS software.

2.2.1.2. Detailed impact analysis methods on land use change impact on ecosystem services (InVEST model)

InVEST model was used to analysis the biodiversity and soil retention function of Poyang Lake wetlands and the typical village. Statistical method was used to analyze the migratory bird change along with land use change. And we used the annual bird observation data to reflect the bird change trends. The details of the model are described as below.

(1) InVEST model – analysis of biodiversity:

The InVEST biodiversity model combines information on LULC and threats to biodiversity to produce habitat quality and rarity maps. This approach generates two key sets of information that are useful in making an initial assessment of conservation needs: the relative extent and degradation of different types of habitat types in a region and changes across time. This approach further allows rapid assessment of the status of and change in a proxy for more detailed measures of biodiversity

status. If habitat changes are taken as representative of genetic, species, or ecosystem changes, the user is assuming that areas with high quality habitat will better support all levels of biodiversity and that decreases in habitat extent and quality over time means a decline in biodiversity persistence, resilience, breadth and depth in the area of decline.

The habitat rarity model indicates the extent and pattern of natural land cover types on the current or a potential future landscape vis-a-vis the extent of the same natural land cover types in some baseline period. Rarity maps allow users to create a map of the rarest habitats on the landscape relative to the baseline chosen by the user to represent the mix of habitats on the landscape that is most appropriate for the study area's native biodiversity.

Habitat quality depends on the strength of the range and intensity of human land use and increasing land use intensity inevitably lead to a decline in the surrounding habitat quality as the habitat fragmentation, marginalization and degradation. Habitat quality also depends on the threats, such as agriculture, traffic construction, urban construction, rural construction, and so on. ach threat source needs to be mapped on a raster grid. A grid cell value on a threat's map can either indicate intensity of the threat within the cell (e.g., road length in a grid cell or cultivated area in a gird cell) or simply a 1 if the grid cell contains the threat in a road or crop field cover and 0 otherwise. So in this model, the strength of the threats can be indicated by numbers between [0, 1].

The impact of threats on habitat in a grid cell is mediated by four factors. The first factor is the relative impact of each threat. Some threats may be more damaging to habitat, all else equal, and a relative impact score accounts for this. The second mitigating factor is the distance between habitat and the threat source and the impact of the threat across space. In general, the impact of a threat on habitat decreases as distance from the degradation source increases, so that grid cells that are more proximate to threats will experience higher impacts. The third landscape factor that may mitigate the impact of threats on habitat is the level of legal / institutional / social / physical protection from disturbance in each cell. The model assumes that the more legal / institutional / social / physical protection from degradation a cell has, the less it will be affected by nearby threats, no matter the type of threat. The relative sensitivity of each habitat type to each threat on the landscape is the final factor used when generating the total degradation in a cell with habitat. The model assumes that the more sensitive a habitat type is to a threat, the more degraded the habitat type will be by that threat. A habitat's sensitivity to threats should be based on general principles from landscape ecology for conserving biodiversity

In this study, habitat quality index was used to assess the habitat quality, the function is as follows:

$$Q_{xj} = H_j\left(1 - \left(D_{xj}^z \Big/ \left(D_{xj}^z + k^z\right)\right)\right)$$

where Q_{xj} is the habitat quality of grid x of j land use/ cover, while z (we hard code z = 2.5) and k are scaling parameters (or constants). Q_{xj} is equal to 0 if Hj = 0. Qxj increases in Hj and decreases in Dxj. Qxj can never be greater than 1. The k constant is the half-saturation constant and is set by the user. The parameter k is equal to the D value where $1 - \left(D_{xj}^z \Big/ \left(D_{xj}^z + k^z\right) = 0.5\right)$.

$$D_{xj} = \sum_{r=1}^{R}\sum_{y=1}^{Y_r}\left(W_r \Big/ \sum_{r=1}^{R} W_r\right) r_y i_{rxy} \beta_x S_{jr}$$

The i_{rxy} is the threat of grid y of threat factor r(r_y) on the habitat.

$$i_{rxy} = 1 - \left(\frac{d_{xy}}{d_{rmax}}\right) \quad \text{(linear)}$$

$$i_{rxy} = \exp\left(-\left(\frac{2.99}{d_{rmax}}\right) d_{xy}\right) \quad \text{(index)}$$

The dxy means the Euclidean distance between grid x and grid y, d_{rmax} means the max Euclidean distance of threat factor.

Wr is the weight of threat factor r, indicating the degree of damage from threat factor r.

β_x is the level of accessibility of grid x, while 1 means the highest accessibility.

S_{jr} is the sensibility from land use/ cover j to threat factor r, 1 means the highest senibility.

The parameter k is equal to the D value where $1-\left(D_{xj}^{z}/\left(D_{xj}^{z}+k^{z}\right)\right)=0.5$.

H_j is the land suitability of j land use/ cover.

2) InVEST model –analysis of soil retention

Water erosion is the main soil erosion types in Poyang Lake Wetland. In the InVEST Model, the water erosion is assessed by USLE (Universal Soil Loss Equation, USLE), the equation is as follows:

$$USLE_x = R_x \cdot K_x \cdot LS_x \cdot C_x \cdot P_x$$

where USLEx is the soil erosion amount ($t\cdot hm^{-2}\cdot a^{-1}$) of grid x; R_x is rainfall erosivity ($MJ\cdot mm\cdot hm^{-2}\cdot h^{-1}a^{-1}$); K_x is soil erodibility ($t\cdot hm^{2}\cdot h\cdot hm^{-2}\cdot MJ^{-1}mm^{-1}$);$LS_x$ is slope length and slope steepness factor which is dimensionless; C_x is vegetational cover factor which is dimensionless; Px is management factor which is dimensionless.

According to the transport path of sediment, each grid will keep some sediment, $SEDR_x$ is the quantity of soil conservation; SE_x is the conservative efficiency; $USLE_Y$ is the quantity of soil from the upper slope grid y; SE_Z is the quantity of soil conservation of the upper slope grid.

$$SEDR_x = SE_x \sum_{y=1}^{x-1} USLE_Y \prod_{z=y+1}^{x-1} (1 - SE_Z)$$

Potential soil conservation quantity （$t\cdot hm^{-2}\cdot a^{-1}$）can be calculated by the equation as follows:

$$SEDRET_{xD} = R_x \cdot K_x \cdot SL_x \cdot (1 - C_x \cdot P_x) + SEDR_x$$

Basic parameter and data:

1) Parameter 1: Land use/ cover data

Source: remote sensing interpretation or others

2) Parameter 2: rainfall erosivity data

Source: Fouriner Index, $R = 4.17 \cdot \sum_{i=1}^{12} \frac{j_i^2}{J} - 152$

where j is monthly total precipitation; J is annual total precipitation; i is the number of month.

3) Parameter 3: soil erodibility factor

Source: Soil type model or reference

$$K = \frac{2.1 \cdot 10^{-4} \cdot (12 - O) \cdot M^{1.14} + 3.25 \cdot (S - 2) + 2.5 \cdot (P_j - 3)}{100}$$

where K: soil erodibility factor;

O: organic matter percentage ;

M: Soil grain size distribution parameters;

S: Soil structure hierarchy;

Pj: penetration hierarchy.

4) Parameter 4: ground cover factor (C)

Source: expert consultation or reference

5) Parameter 5: ground cover factor (C)

Source: expert consultation or reference

6） Parameter 6: ground cover factor (C)

Source: sediment blocking efficiency by surface matter

7) Parameter 7: the slope length and slope steepness factor

Source: calculative method is as follows,

The slope factor：

$$S = 10.8 \sin\theta + 0.03 \quad \theta < 5°$$

$$S = 16.8 \sin\theta - 0.5 \quad 5° \leq \theta < 10°$$

$$S = 21.91 \sin\theta - 0.96 \quad \theta \geq 10°$$

Θ is slope degree.

The slope length factor： $L = \left(\frac{\lambda}{72.1}\right)^{m}$

$$m = 0.2 \quad \theta \leq 1\%$$

$$m = 0.3 \quad 1\% < \theta \leq 3\%$$

$$m = 0.4 \quad 3\%\theta < 5\%$$

$$m = 0.5 \quad \theta \geq 5\%$$

Θ is slope degree.

2.2.2. Giam Siak Biosphere Reserve in Indonesia

2.2.2.1 Detailed data analysis methods on land use change and driving forces

Collecting data used a number of techniques during the study period. First is in depth the interview method with the informer, either a key informer as well as a usual informer. In depth interview method is used to know the structure of society and their perspective about the environment. Key informants are bomo or village dukun who has dependency to forest for supply

medicine material, the second is village administrator (head of village, secretary, and other staff) who know common situation about population, land use change, and other village problems. The second is by using Participatory Rural Appraisal method with Focus Group Discussion activity among stakeholders as the key tools. In this activity respondents involved consisted of 20 - 30 persons who represents young people, elder, and village officer (Figure 2). FGD used for making maps of the village related with the changing of land and other ecosystem services. During FGD activity, respondents were separated into 4 groups. Those are: (1) land use change group, (2) village structure and infra-structure group, (3) income and expenditure group, and (4) farming system in the village and other problems group.

The map made is the map of the past, (30 years ago, or more), present and future plan of village management related with the ecosystem. This method is part of visual anthropology who describes the ideas and local perspective on the management of nature. In addition, to know the content of biomass and biodiversity in the forest of Bukit Batu Nature Reserve this research used the techniques of ecology that is counting tree ring, height of trees, and tree density through the plot made. The plot observation is measured in 50x50 meters.

We used GIS Analysis to analyses the land use change in the Giam Siak Biosphere Reserve.

Based on the Land Use Map issued by the Indonesian Ministry of Forestry, attributes map then extracted into a database file that can be processed by Microsoft Excel. The land Use change were analysed during the period of 2000 until 2012.

2.2.2.2. Detailed impact analysis methods on land use change impact on ecosystem services

To know the impact of land Use change to the ecosystem services, the ecosystem services assessment were done in the Temiang and Tasik Betung Villages. The analyses based on the guideline for Undertaking Ecosystem Assessment by the Sub-Global Assessment Network.

2.2.3 Tanguar haor in Bangladesh

2.2.3.1. Detailed data analysis methods on land use change and driving forces

The data of PRA was summarized and then qualitative description was used to analysis data. Data of household questionnaires were placed in spread sheet and then putted in excel software and then were analysis by mathematical statistics/computer program with the help of SPSS.

The image classification was done using ERDAS Imagine 11 and Arc GIS 10. With the help of Land sat imagery 2010, a future scenario of land use change in 2020 has been predicted. The spatial and temporal changes of land use and other resources in the study area were analyzed. Besides, the study focused the subsequent impacts of these changes on plant and bird diversity as well as household dependence in haor ecosystem.

The collected meteorological data (temperatures and rainfall) were collected from the meteorological department and then compiled in an excel spread sheet to formulate regression graph, where linear regression (Y=a+bx) as well as regression co-efficient (R2) value were determined for the proper assessment of long term temperature and rainfall trend in the study area.

Moreover, the Standardized Precipitation Index (SPI) of the location was calculated using following formula (Edwards and McKee, 1997):

$$SPI = \frac{Xi - \overline{X}}{\sigma}$$

Where, SPI is Standardized Precipitation Index; and σ are ith year precipitation, long-term mean of precipitation and standard deviation of mean, respectively. Results of household questionnaire and second hand data were analysis by mathematical statistics using SPSS software.

2.2.3.2. Detailed impact analysis methods on land use change impact on ecosystem services

Tanguar haor, like all other haor areas is predominantly a rice growing area. For the measurement of the changes of rice varieties over time, rice varieties were categorized into high yielding rice (HYV)

and local rice (LR). Different types of rice varieties both past 10 years and present year's data were collected through questionnaire survey. After that all rice varieties were compiled and determined man and presented in tabular form and then these were compared (past 10 years and present year) to show changes expressed in percentage.

To indicate the importance and species richness of different plant species i.e. 10 years back and present in the homestead area Relative Prevalence (RP) of species were calculated through the following equation.

RP = Population of the species per homestead X percent homesteads with the species.

The Shannon-Wiener Index (SWI) was used to evaluate the species richness and abundance of trees and birds in all three locations (Margurran, 1988). The proportion of species (i) relative to the total number of species (pi) was calculated and then multiplied by the natural logarithm of the same proportion (lnpi). The resulting product is summed across species, and multiplied by 1.

$$SWI = -p_i\left[\ln\left(p_i\right)\right]$$

For measurement of changing scenario of different bird species over time in the study area, respondents opinion were gathered for number of species comparing 10-12 years back and at present from surrounding 5 beels out of 120 beels and data base of IUCN. The changing scenario of bird species

In addition, Tanguar Haor is very rich in fish biodiversity along with other flora and fauna. Different types of fish species both past 10 years and present year's data were collected from secondary sources. After collection of fish species from the study site they were categorized in to seven categories such as very common, common, fairly common, few, very few, occasional and very rare. After that all fish categories were compiled to formulate the table and then they were compared to give change percentage from 10 years back to present.

Data of swamp forest area were collected from forest department in the study area for determining the changes. Both past 10 years and present year's data were collected and compiled in a table to formulate mean value. Up next they were compared (past 10 years and present year) to give change percentage.

2.3 Description of study areas

2.3.1 Poyang lake wetland in China

2.3.1.1. Criteria for selection of the study area

Poyang Lake is the largest freshwater lake in China. During the summer, the lake's water surface area decreases to 4000 km2 (Shankman and Liang 2003), and by the start of autumn, natural drainage leads to the exposure of large mudflats and independent lakes (Yesou et al. 2009). These dramatic hydrological changes led to equally dramatic changes in the ecological processes in Poyang Lake and directly affected the characteristics of its different habitats and its rich biological diversity (Li et al. 2005; Zheng 2009; Harris and Zhuang 2010). Because Poyang Lake has an abundance of aquatic and submerged plants that provide important food resources, tens of thousands of migratory birds overwinter here every year (Li et al. 2005).

But Poyang Lake wetland is also an agriculture area and has high population density (482 person/km2), human activities has big pressure on ecosystem. In recently years, large land use changes had happened in Poyang Lake wetlands. Key ecological projects, such as the "return farmland to lake" and "return farmland to forest" projects are carried out in Poyang Lake area in the past 10 more years, which make big change on ecosystem services. And it is a idea area for the study of "Holistic Assessment of Land-Use Change and Impacts on Ecosystem Services of Wetlands".

We also chose three typical villages for our study. The typical villages provide representative examples of human activity in the Poyang Lake wetlands. Human activities including planning, aquaculture, labor forces exporting and building residence. Key ecological projects, such as the "return farmland to lake" and "return farmland to forest" projects are carried out, in these areas. In

addition, the portion of land use types in typical villages is similar to the whole area of Poyang lake wetland, which means cultivated land, wetland and forest land consist of large portion of the whole area, and residence land is the main type of construction land. Moreover, the habitat in and around the villages is important part of the migratory bird gathering area.

2.3.1.2. Detailed description of the study areas with maps

The Poyang Lake wetland is located in northern Jiangxi Province, China, on the southern bank of the middle and lower reaches of the Yangtze River (28°22′N to 29°45′N, 115°47′E to 117°45′E; Figure 2). It has a climate of subtropical humid monsoon. The average air temperature of the year is 16.5--17.8 ℃ Poyang Lake is the largest freshwater lake in China (water level changes from 9.8 to 15.4 m within a year; Li et al. 2008) and serves as the drainage basin for five sub-watersheds. Water levels in the lake vary seasonally as a result of water exchange between the Yangtze River and the lake during flooding and dry periods. During the summer, the lake's water surface area decreases to 4000 km2 (Shankman and Liang 2003), and by the start of autumn, natural drainage leads to the exposure of large mudflats and independent lakes (Yesou et al. 2009).

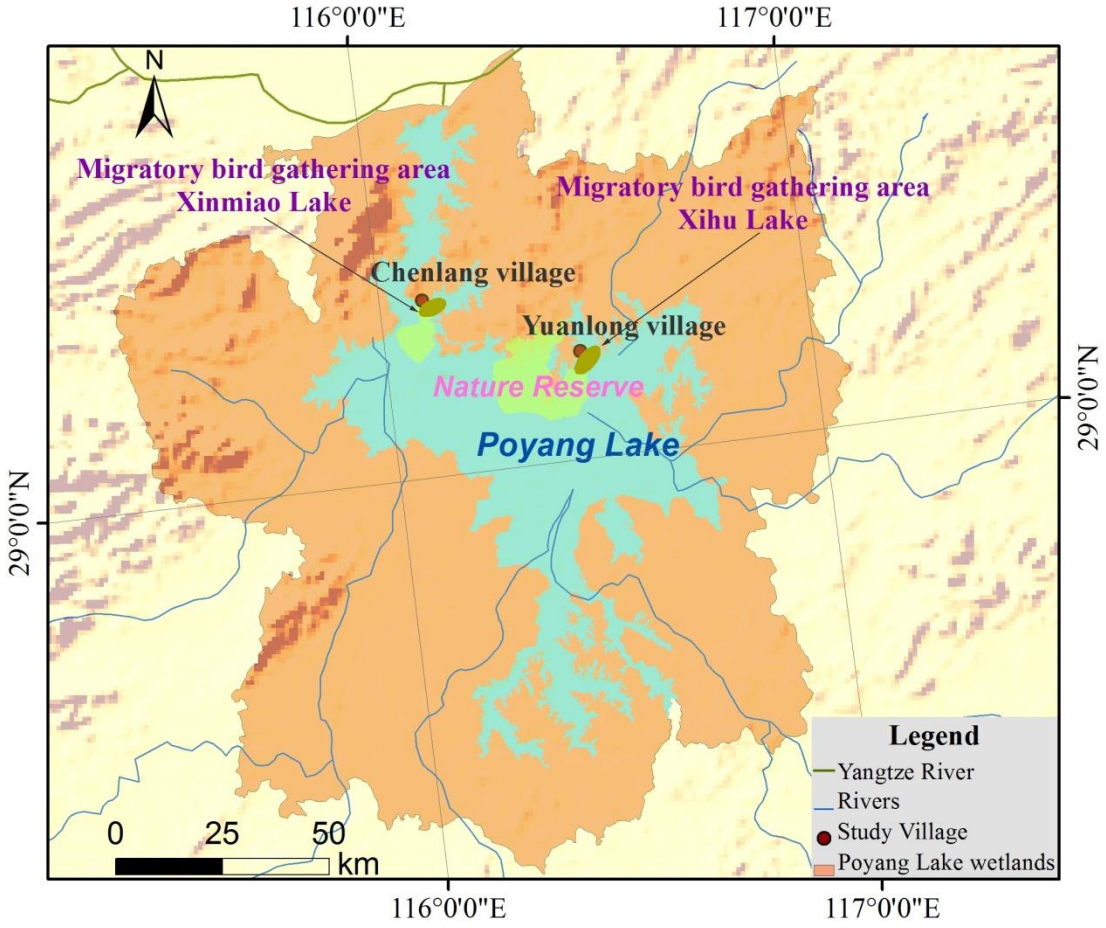


Figure 2 Geography of the study area

These dramatic hydrological changes led to equally dramatic changes in the ecological processes in Poyang Lake and directly affected the characteristics of its different habitats and its rich biological diversity (Harris and Zhuang 2010). Because Poyang Lake has an abundance of aquatic and submerged plants that provide important food resources, tens of thousands of migratory birds overwinter here every year (Li et al. 2005), ninety five percent of the global population of an endangered species, the oriental white stork (Ciconia boyciana), and 99% of the global population of the critically endangered Siberian crane spend the winter here. Half of the world's surviving population of two vulnerable species, the swan goose (Anser cygnoides) and the white-naped crane

(Grus vipio) spend the winter here. Winter records show an average total of 425 000 waterfowl, with a peak of 726 000 waterfowl reported in 2005 (Qian et al. 2009). The Poyang Lake wetland is home to 310 species of birds, of which 16 are listed as threatened by the International Union for the Conservation of Nature (IUCN, www.iucnredlist.org).

Poyang Lake wetland consist of 12 counties, which including the city of Nanchang and Jiujiang. It is one of 9 grain-producing area in China. In 2010, the total grain-production of this area is 4.4 million ton. And the total population of 9.8 million, with a density of 482 person/km2, 59.5% of the total population is comes from rural area. Facing big ecosystem and environment pressure in these area and recognizing the importance of this wetland habitat, the Chinese government implemented "returning farmland to lake" (RFL) and "returning farmland to forest" (RFF) ecosystem restoration projects, which began in 1998 and 2000, respectively, which leading positive effects on the ecological environment (Li et al. 2009).

2.3.2 Giam Siak Biosphere Reserve in Indonesia

2.3.2.1. Criteria for selection of your study site

The criteria to select the study site: 1) Wetland area where the high human disturbance occur (conssession area, land use change for oilpalm and rubber plantation), 2) Lack of the data information, 3) Have been declaired as Biosphere Reserve, therefore need more information for the management purposes. 4) Unique ecosystem and diversity of flora and fauna.

2.3.2.2. Detailed description of study areas with maps

The research study is in the Giam Siak Biosphere Reserve which is divided into terrestrial zone areas: 178,722 ha (about 25% of the total areas), terrestrial buffer zone about 222.426 ha (32% of the total areas) and terrestrial transition about 304.123 ha (43% of the total areas) with the total areas were 705.271 ha of peat land. Giam Siak Biosphere reserve is in the Riau province (West Sumatera). The Core area is dominated by peat swamp forest types, and is recognized as supporting a significant water reservoir supplying the buffer zone and transition area, and in controlling floods. The Buffer zone is composed mainly of industrial plantation forest managed by Sinar Mas Forestry and Partners. The transition area (304,123 ha) is used for settlements, oil palm plantations, rubber plantation, livelihood farms, and other commercial non-forestry land uses (Figure 3).

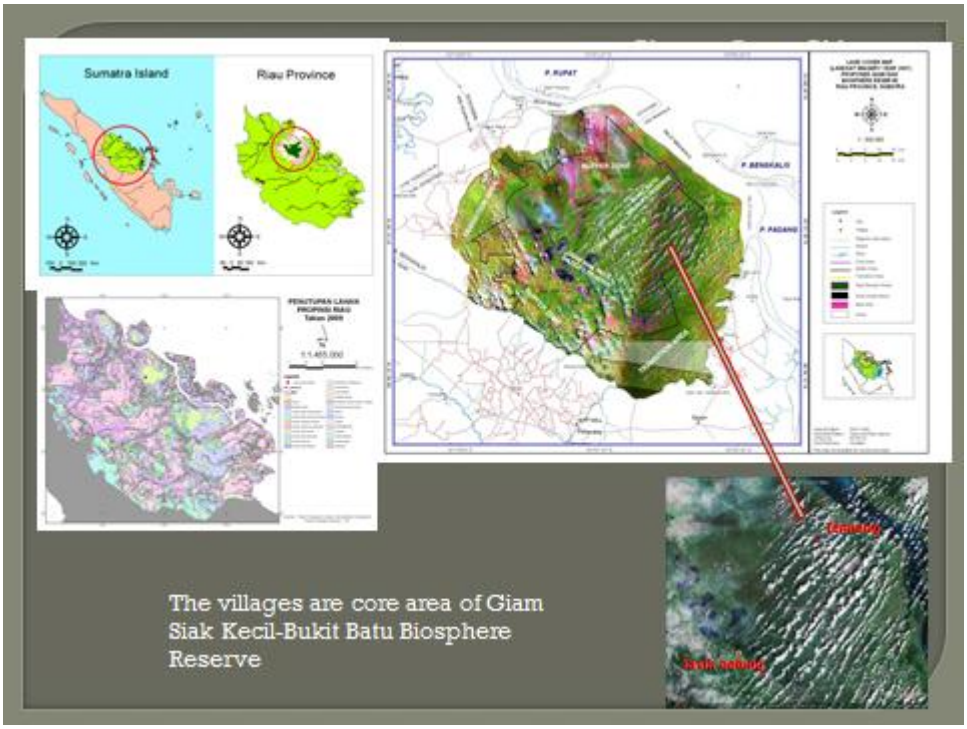


Figure 3 The study site in the Giam Siak Kecil – Bukit Batu Biosphere Reserve.

Two villages were selected to study the land use change and their direct and indirect factors, those were Tasik Betung and Temiang Villages.

(1) About village:

Tasik Betung Village :

The research was carried out on 16 – 25 April 2012 in Tasik Betung village, which is belonging to Sungai Mandau District, Siak Regency, Riau Province. This village is in the transition zone of Giam Siak Kecil Bukit Batu Biosphere Reserve. Around the village is peat land ecosystem. Melayu ethnic group is the main local people, with Malayu language as daily conversation. The primary livelihood systems are rubber plantation, shifting cultivation, fisheris, and non-timber forest product (honey). Currently, the villager in Tasik Betung starts to cultivate oil palm.

Temiang Village:

Land use change effect and biodiversity studies conducted on July, 2nd to 8th, 2012 in Temiang Viilage, Biosphere Reserve of Giam-Siak, Riau. Temiang village is one of 14 urban villages in the districts located in Bukit Batu, Bengkalis, Riau. The area is belonging to Bukit Batu biosphere reserves. The central government and the provincial government established Giam Siak Kecil-Bukit Batu in Riau as biosphere reserves. This biosphere reserve is submitted by Sinar Mas Forestry, which allocates 72,255 hectares of forest production for permanent conservation. This area is part of ecological corridors that combines two wildlife reserves, the Giam Siak Kecil (84,967 ha) and Bukit Batu (21,500 ha). The concept of biosphere reserves, an integrated and comprehensive management system, is enabling the sustainable use and community involvement in the management.

Bukit Batu area has not escaped from the land use changes. This area in the recent past (twenty years ago) is still filled with primary or secondary forest. A human need of land is only for fields and rubber gardens while the ownership of land was unbundling and limited.

(2) About local people and traditional knowledge

Soil Types Knowledge:

Temiang traditional knowledge related to natural resource management as the basic guidance for

survival. One of the knowledge is about the classification soil types. This knowledge is useful for them, when they wanted to set up a type of crop that will be cultivated. This knowledge is useful when they choose the area to cultivated rice or rubber.

These are some of the soil types in the Teming village: (1) Pasir bulan is the soil type with the color is white and sandy. This soil is good for cultivate oil palm, rice, and rubber. (2) Redang, the type of peat soil which is only suitable to cultivate rice and rubber. (3) Bencah is a terminology used by the public to refer to peat which has been inundated with water. The term bencah is also used to refer agricultural land to cultivated the rice. And (4) Clay is a type of soil that has a soft texture, yellowish or blackish. Clay is the based material to make bricks. This type of soil is rarely found in the Teming village. Perun is terminology that used for burned of land, so the name of perun is not on the type of soil but on the activities contained therein.

The traditional knowledge of Temiang village community could be developed and used by the government as the basic study, to manage the sustainability of ecosystem for their life. The adoption of traditional wisdom is one way to protect the nature resources from the disturbance, and involving the people in conservation activities as the main factor to support the sustainable of natural resources management.

Temiang villager has some local rice varieties. These are some way they cultivate the rice such as: (1) they cultivated among the rubber trees, while they are waiting to be tapped, (2) in the wetlands, (3) and some planting in the field. Several types of rice were known and some of them were extinct, due to decrease of the rice field. Government introduced the rice varieties, with period of harvest is ones in one year. While for other one, those are shorter and faster to be harvested.

Other types of local rice are planted with various ways. In the past, when the access road is still difficult, the climatic condition is uncertain, they live as in isolation. To that end, food needs must be fulfilled while forest products cannot be the staple food and rubber tree has its annual. While waiting rubber to be tapped or also collected and sold, they planted rice. Local rice varieties known in the community are pucuk rice, kledang rice, telu belalang rice, jintan rice, cenani rice, ramos rice, Payoh rice, black sticky rice, putih rice, and ketiti rice. Rice varieties are planted in different lands. Pucuk rice, for example, is planted on hilly land of clay soil.

Tasik Betung people have local paddy. Unfortunately the local paddies were extinct but still leave on the people’s memory. People prefer to plant rubber or oil palm than rice farming, Rice requires more time and effort in planting. For daily need, Tasik Betung people prefer go to town to gets rice rather than self-production. It’s one reason why local paddy lost gradually. The local paddy in Tasik Betung area are; 1. Putih paddy, this paddy need 4 months and planted on the hill area. 2, Jambay, the gesture of this paddy is soft and rather long. Planted on swamp area and need 7 month to harvest. People also call this paddy as women paddy and the swamp that planted was call with sawah. 3, Padi kuning, even the name is paddy kuning (yellow paddy) but actually the color of this paddy is red. 4, Padi Komat, the texture is soft and the smell is fragrant. This paddy planted on the hill. 5, Padi Pulut or ketan. It has two kind of pulut paddy; white pulut and black pulut. 6, Paddy ketitir, this paddy more soft than komat, it has fragrant smell, it planted at hill. 7, Paddy bua koeh, it has fragrant smell but the texture is rough and planted at hodang land. 8, Paddy kuku balam, there is no information about this paddy.

Tasik Betung people also have local knowledge about land and its utilization. Where the land is is good for settlement, agriculture, plantation, or paddy field. According local people, they know hokat land is good for paddy. The characteristic of hokat land are; the color is yellow, clay and its hill land. Kasang land is the mixed land between soil and sand, the characteristic of the land is hot so it’s not good for field but better for settlement. Hodang land is good land for paddy or other agricultural system. Awang land means peat land. Local people was planted paddy in this land.

History of Rubber and Oilpalm Plantation:

Rubber is an integral part of the lives of the people of Riau. They call rubber with getah, the same as the name used in the Malay Peninsula. The development of rubber plantations cannot be separated from the crisis of the tobacco and coffee commodity in Dutch East Indies colonial. Dutch

East Indies government gives orders to build a rubber plantation. In 1864, rubber was introduced and developed in Indonesia, the first opened in Ciasem and Pamanukan area (West Java) by Hofland (the Dutch company). At that time, the species of rubber that planted is "rambung" (Ficus Elastica). The other one Hevea brasiliensis planted in 1902 in East Sumatra. Rubber plantations in Indonesia are more developed after the Netherlands Indies open the door for foreign investors, especially from the UK, Holland and Belgium and America. Along with that, the Dutch government for the first time introduced a system of big plantation (modern) which opened in Indragiri in 1893. Along with the demand for rubber, the influence of "boom" for rubber prices after World War II, rubber was begun to develop. Riau people have known rubber long before it was introduced by the colonial Dutch East Indies. Rubber is already part of the cultural life of the farmers in Riau. Besides supported by natural conditions, as well as agriculture-gardens for the people of Riau is a form of adaptation in agriculture, because of the grip of climate and soil fertility in Riau were not as good in Java which is loaded with the intensification of crops, plantation subsector develop more faster than agricultural crops. The farming culture in Riau is farm life centered on dry land. The main crops are rubber and coconut.

Most of Temiang people depends their life on rubber. Some people rent rubber plantation, others own plantation by themselves. Most people have about 1 ha plantation rubber area with about 300 numbers of rubber trees. Associated with an area of rubber plantation owned, some participants said that the extensive gardens that belonged to them more narrow than the time it used to be. First, they had a rubber plantation of 2-3 ha, now remaining only less than 2 ha. It happens because there are more people who come to the area and use the land also as plantation. In summer, people would tap rubber every day and there will be agents who come to every house to deliver results. Each kilo is priced at Rp 9000, every five days they were able to obtain about 15 kg of rubber. Although some people also have rice field, but their main income still comes from the rubber. They spend agricultural products for their own consumption.

Besides rubber and coconut, Riau governments have also begun to establish palm oil as the main commodity. There are several reasons why Government put palm oil as the main commodity, among others: First, in terms of physical and environmental circumstances of Riau allows development of oil palm plantations; Second, soil conditions allow for the planting of oil palm will make production more than other regions; Third, in terms of marketing products Riau has the advantage, because of its strategic area near international markets of Singapore. Temiang people also cultivate oil palm, from 2-3 years ago; a few people have also dependent of oil palm plantations. Some of them have their own plantations, some are rented from others. The result will be sold at the agents who came to this village.

Local Knowledge about Disease and Medicinal Plants:

The people who do not visit the doctor and other medical are considered healthy (Zola, pp. 111, 1993). Although there is an argument to say that while we are at some point must have experienced pain, but the disease is generally considered to be relative as abnormal symptoms, are rare and exceptional. Perceptions of disease in each community is different, in the United States, back pain is commonly found among lower-class women, back pain is not considered a disease but a symptom seen as an usual everyday occurrence (Zola, pp. 115, 1993). To that end, a disease associated with the social context in which it occurs and in terms of where it is seen and understood. For example, fatigue is a sign that not only the physical state can be regarded as an unusual condition but is also associated with various diseases.

In Temiang village, a person is considered ill when he was unable to perform the usual job retention and if the pain in one part of their body. When someone is sick and not physical pain, Bomo will heal the person by traditional methods, traditional medicine is called uwas-uwas. The disease is much complained of by the public is fever (based on interviews with Pak Kamis (Bomo, 79 years) and Ibu Anizar (49 years). In an examination usually begins with the questions: what is felt ill, this question is the starting point of analysis, namely determination of the specific location on the body, usually patients who came were also asked about their body parts which they consider their most important and they are worried about if you have pain in those locations. Base on interview

with Pak Kamis if the affected part is the location of the ear or eye, they do not feel worried about this part.

There are different ways of expressing the physical disorder which is divided into two kinds of physical problems, first, the is more limited and emphasize specific dysfunction, meaning that there is one part of body that does not function as usual, the second, a physical disorder that emphasize a more general difficulty. Based on interviews with people who are sick, they will naturally complaint regarding the parts of the body that feels pain, dysfunction and affect their activity. If they feel sick at the back, they will call back pain. It could be argued that the social and culture factors, social background give effects on different responses to the experience is basically the same. The perception of any person against the disease, it could be the same, but it can also differ (Suparlan (Ed.) 1993).

When people sick, they would choose a doctor for first aid, when it is not healed, they will choose Bomo or shaman. There are several stages of the treatment process, it means that when the disease cannot be cured with only one type of leaf or plant, then the treatment will be continued using more than one type of plant as well as on. Usually the first time, it will use Medang leaf. If it is not healed, Bomo will use two kinds of plant leaves, Medang leave and Menjuang leave. If not, then Bomo will added more leaves from different species and become five species, pagar leaves and pulam bayam leaves. If it is still not healed well, the patient's family set up a kind of dish, called semah, which put on field (semah ladang). This is done by Bomo. Then if there is no change, then semah will put in the forest, the offerings are put in the forest (semah uyan). This method actually is rarely done, and if there is no change in the patient- the healing will be done by a shower (mandi ukup). Bomo will use a liquid that has been placed in a big bowl; the water has undergone a series of rituals. Then water will be spray to patient. If this does not work, then the patient has to do a kind of shower called mandi buyung, ritual shower by using water in different three places. The water also has been through various rituals.

If this did not work, then the last way is bedikir, the typical ritual treatment of the people. In the ritual, Bomo as healers will go into a trance or unconscious because it has entered the spirit or spirits of ancestors. At that time, the assistant of Bomo will ask whether the patient will be cured or not. If the answer is not going to recover, the family of the patient in order to get ready for the deaths of his family members, but if the answer is that the patient can be cured, then the healing will be continue and it can be combine with medicine from doctor (modern medicine).

Plants have always played important roles in human life throughout the world, especially in terms of health, food, household industry. Temiang people still use medicinal plants to treat diseases, in addition to medication given by a doctor or bought in shops. In terms of making the herbs, people already know what plants will be taken. Usually before use as a medicine, the plant will be placed outside the home first and cannot be used until the shaman or Bomo come. If they use the herbs before Bomo came, the potency of the medicinal plants will be reduced.

Local Knowledge about Plants for Craft

People's knowledge about plants as craft materials collected in this study. Plants are used as a craft is Asau (Pandanus sp.) and Umbai. Usually they take this plant on the edge of the river; Umbai and Asau are easily found in the river by using pompong (small boat). The process of manufacture is obtained through interviews with Mrs. Anizar (49 years). Usually in August, the mothers in Temiang village got busy making handicraft items, since January to July are usually filled with rice planting.

Asau (Pandanus sp.) as Craft Materials

One type of plant used to make the craft is Asau (Pandanus sp.). Asau is one type of Pandanaceae. To make one mat needed 100 leaves of Asau. Before being used for woven, first the leaf of Asau will be discarded from needles, and then dried. After drying, the leaves will be aligned with some tools such as brushes. Asau leaves which are already taken will be neatly folded and then dried and cooked in water. Once cooked in water, the leaves are opened, placed, hung on the wall, and then the sizes of the leaves were equated with a tool called jangka. Then, the leaves will be soaked again

for 3 days and 3 nights, and then it will be dried again for 2 days, and then condensed so that the leaves become malleable and easily molded. It takes about 4 days to make mats from asau leaves.

Umbai as Craft

For making craft, umbai leaves do not need to be boiled. Umbai leaves will be dried leaves and made into household items. Umbai leaves are usually created as a place or container to bring the fish or rice. Crafts made from umbai can last up to half a year, more durable if not exposed to air, when compared with pandan, the endurance of umbai is longer than pandan leaves.

Non Timber Forest Products

Tasik Betung people also had known some non-timber forest product. Commonly, fruits and vegetable are non-timber forest products that produced by local people, even the fruits are self-consume. They have cultivate some fruits that have economic values, those are duren (Durio zibethinus) which is fruit product that has high economic and marketed to Pekanbaru. Nanas hutan (Ananas comosus (L.) Merr), surau/rambutan hutan (Nephelium lappaceum), deruyan/durian (Durio zibethinus), cempedak (Artocarpus champeden), Taeh/mangga hutan (Mangifera), lokup (Mangifera), manggis (Garcinia mangostana), boti batang (Carica papaya), pisang (Musa sp.), duku (Lansium domesticum Correa), and langsat (Aglaia argentea).

The other important NTFPs are honey. Local honey is popular in Siak and Bengkalis. Related with honey, local people have belief that the tree where bee making the nest is sacred spesies with custom rules (Sialang).

2.3.3 Tanguar haos in Bangladesh:

2.3.3.1. Criteria for selection of the study site

Tanguar haor is the largest wetland in Bangladesh comprising of 10000 ha of land area. It is located at the foot of the Khasi Hills under northeastern district Sunamgonj. This wetland has been recognized as wetland of global importance under the Ramsar Agreement since 2000. This wetland is an important resource providing a range of ecological, economic and environmental services as well as providing enormous opportunities of income and employment to around 77,000 population spread over 88 villages (Anonymous, 2007). It also provides a number of national services especially rice and fish production. This also acts as a safe habitat/resting place of thousands of local and migratory birds. Considering the national importance of Tanguar haor wetland and because of tremendous pressure on its resources and damaging of its ecosystems, it has been declared as one of the Ecological Critical Areas of the country in the year 1999. Later on it (in 2000) became the Ramsar site of Bangladesh. Because of the national importance, this wetland has been selected as study area.

2.3.3.2. Detailed description of the study site with maps

(1) Location

The most important wetland of Bangladesh - Tanguar Haor (TH) is located in Sunamgonj district covering an area of 10000 hectares. Geographical position of is at 25° 06”to 25°11”N and 91°01” to 91°06” E. This site is influenced by Dhanu Baulai, Surma and Jadukata Rivers. Meghalayan Hills are in the North from where number of hill streams flows to the Haor. Other important haors like Matian, Shanir and Thapner are very nearby and have some dependency with some degree of variation.

Five large central depression constitute the topography of Tanguar haor wetland wet which are Rowar, Rupaboi, Bherberia, Tangua and Leehchamara flanked by lowdown plain, then sloping upwards lands and then to Indian Hills. About 44 narrow water canals slope down to these beels from Indian territory and 30% of them flow water round the year while rest other remain alive only in monsoon . These water flows (narrow canals and rivers) resulting huge sediments to the Beels and adjacent upland (villages) which area could be easily traced in the satellite Map. Location of tanguar

haor and the study site have been shown in Figure 2 and 3.

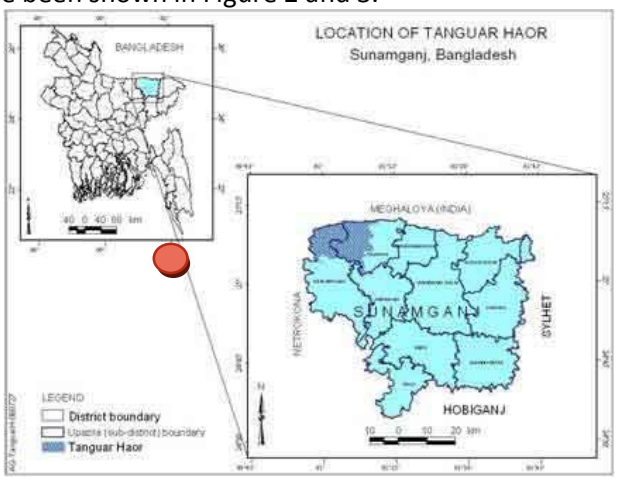


Figure 4 Location of Tanguar Haor wetland showing study site.

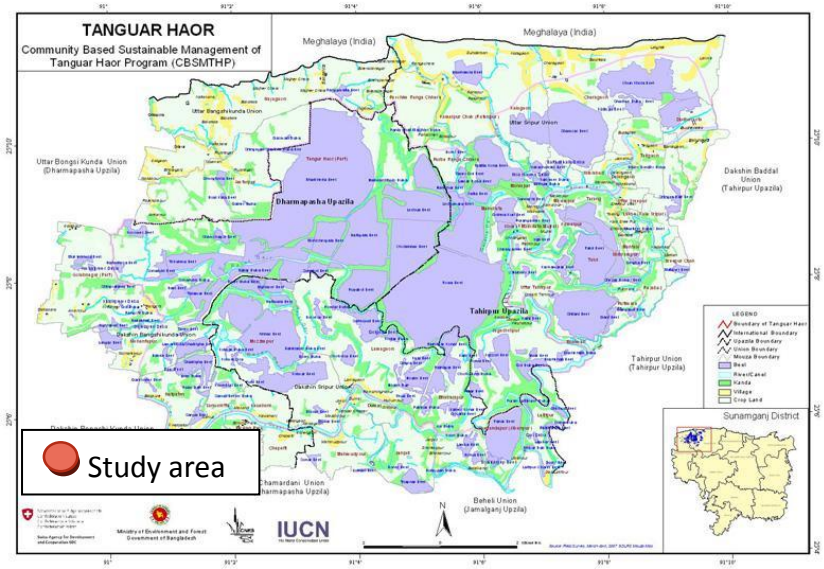


Figure 5 Full Map of Tanguar Haor Area by IUCN Bangladesh office.

(2) Population and Demography

The total number of population in selected three villages (Hkumpur, SilonTahirpur and Golabari) villages was 460 in 2001 which is now increased to 1120 in 2011 (Figure 6). This indicated that population increased 2.43 times during the last years. Among the villages Silon Tahirpur showed the highest population in 2001 followed by Golabari and Hukumpur. On the other hand Hukumpur showed the highest population in 2011 as compared to Silon Tahirpur and Golabari. Despite large-scale migration into the area, the population density of the haor basin is relatively low compared to the rest of the country.

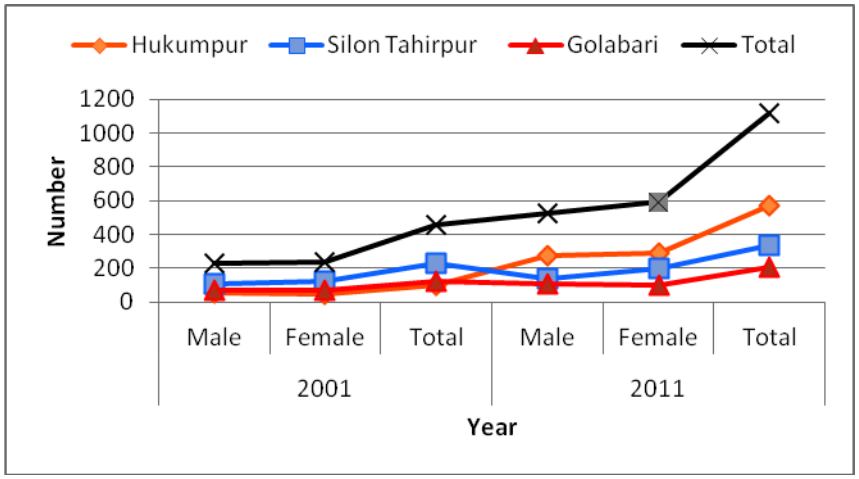


Figure 6 Population distribution in selected three villages of Tanguar haor wetland.

The education level of the population of the study sites was low compared to national level while most of them passed the primary level. The average family size of the respondent was 6.28, while about half of the respondents had medium sized family. It revealed that the family size was relatively bigger in the study area than that of the national average family size of 4.50 (BBS, 2011). This might be due to joint family system in the studied community. Regarding farm size, marginal farm size group was dominating followed by small and landless groups. The average farm size was 0.33 ha per family which is almost half of the national average of 0.67 ha (Krishi Dairy, 2012). This information clearly stated that respondent community was the resource poor and mainly depended on common natural resources of haor.

The income level of the respondents revealed that majority of the respondents were extreme poor. The poor income of the respondents was possibly due to shrinkage of livelihood opportunities like resource collection from the haor. In view of occupation types/economic activities, majority of the respondents (90%) were dependent on fishing, closely followed by farming and day laborer. The other minor occupations were small business, duck rearing, sand and coal collection, bird hunting and trading, boatman etc.

3 Results and Discussion

Explain your actual findings, including figures, illustrations and tables. Make comments on the results as they are presented, but save broader generalizations and conclusions for later. Discuss the importance of your findings, in light of the overall study aims. Synthesize what has (and has not) been learned about the problem and identify existing gaps. Recommend areas for further work.

3.1 Analysis of land use change and ecosystem services in the three wetlands

3.1.1 Poyang lake wetland in China

3.1.1.1 Changes of land use in past 20 years

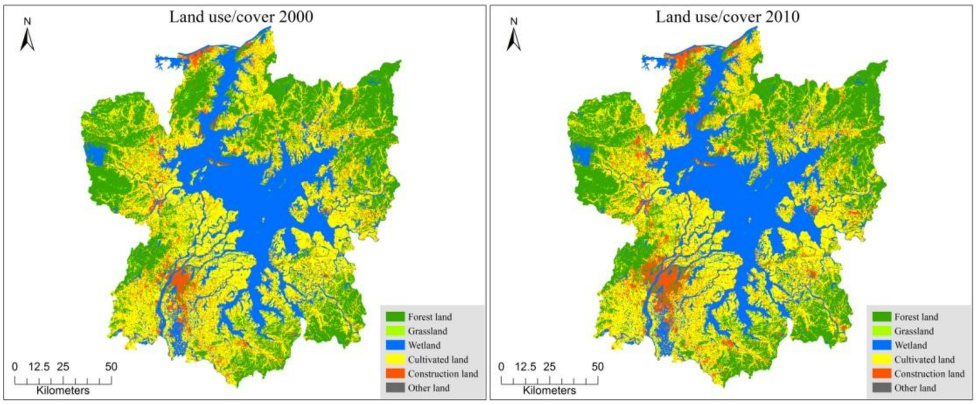
(1) Land use change in the whole wetland:

In 2000, cultivated land covered the largest area of 752614.38 ha or 37.11% of the Poyang lake wetland's total area. The forest and wetland covered the 27.65% and 26.90% of the total area while construction land was 7.32%. Grassland and others cover only 0.53% and 0.49% of the total area respectively. In 2010, cultivated land covered the largest area of this wetland, which was 70499.07 ha or 34.76% of the total area. The forest and wetland covered 28.22% and 26.56% respectively and construction land covered 9.36%. The grassland and others only covered 0.62% and 0.48% respectively.

During 2000 to 2010, the forest area increased sharply, the increase area was 11543.04 ha accounting to 2.06% of the total area. Whereas, the area of wetland presented decrease in a degree, the decrease area was 7008.48 ha or 1.28%. While the grassland increased largely, the increase area was 1755.90 ha accounting to 16.38% of the total area. The cultivated land decreased 6.33% or 47615.31 ha and the others had a slight decrease of 72.45 ha or 0.74%. The construction land sharply increased by 27.88% or 41397.30 ha.

Table 1 Area and proportion of Land use/ coverage at Poyang Lake wetland (2000-2010, ha, %)

Land use/ cover type	**Area of 2000**	**Area of 2010**	**Area change**	**Proportion change**
Forest	560878.56	572421.60	11543.04	2.06
Grassland	10722.60	12478.50	1755.90	16.38
Wetland	545628.51	538620.03	-7008.48	-1.28
Cultivated land	752614.38	704999.07	-47615.31	-6.33
Construction land	148494.15	189891.45	41397.30	27.88
Others	9852.12	9779.67	-72.45	-0.74



a) 2000 a) 2010

Figure 7 Land use/cover of Poyang Lake wetlands

(2) Land use change in villages surveyed

From land use cover change study of 3 typical villages, we got the conclusion that during 2000—2013: (1) For the reason of ecological conservation projects and cultivated land abandoned, the intensify of land use in Poyang lake wetland had been decreased (average rate was 4%), and the vegetation coverage had been increased (average rate was 10%). (2) Land use/cover change (LUCC), which caused by ecological conservation projects is the main LUCC type in Poyang Lake wetland. And cultivated land abandoned, plant structure adjust is very common in Poyang Lake wetlands. (3) Multiple cropping index of the paddy field had been decreased (average about 15%, data from household questionnaire). And at the same time, household questionnaire analysis result shows that the phenomenon of cultivated land transfer is very common.

Table 2 Change characteristic of Land use/cover change in typcal villages(2000—2013; ha, %)

	Chenlang village			Shuanglong village			Yuanlong village		
Land use/cover type	2000	2013	rate of change	2000	2013	rate of change	2000	2013	rate of change
Forest land	54.8	70.6	28.8	36.3	41.9	15.5	130.1	133.5	2.6
Grass land	10.1	32.9	227.7	14.6	32.1	119.5	0.7	22.5	3231.9
Cultivated land	166.9	108.8	-34.8	91.0	63.5	-30.2	94.3	57.4	-39.1
Construction land	12.4	14.9	19.6	20.9	25.2	20.8	15.1	19.8	31.3
Wetland	11.5	11.5	0.0	3.7	3.7	0.0	9.8	15.9	62.7
Unused land	53.0	50.3	-5.1	0.9	0.9	0.0	8.6	8.6	0.0
Intensify of land use	246.2	236.5	-4.0	278.7	267.5	-4.0	248.6	239.1	-3.8
vegetation coverage	20.5	32.8	--	30.4	44.2	--	47.1	56.1	--

3.1.1.2 Driving forces of land use changes

(1) Natural factors

During PRA process, the stakeholders pointed out that precipitation of the study area had been decrease in the past ten or more years, and this can make some wetland loss to some extent. Moreover, according to existing meteorological data of 6 weather station in and around Poyang Lake wetlands, from the year 2000 to 2011, precipitation of almost all of station had experienced a decrease trends (Figure 8). Precipitation decreasing can make some wetland which have low water content to become grassland.

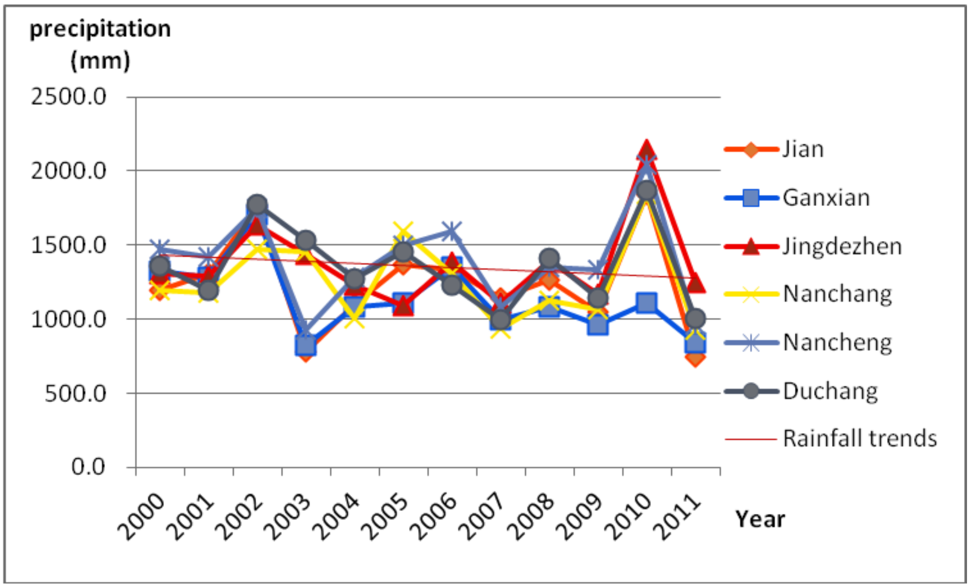


Figure 8 Annual precipitation of from 6 weather station in and around Poyang Lake wetlands (2000—2011, mm)

Extreme weather made extraordinary rainstorm in 1998 in Yangzi river watershed, which made big flood and had caused major personnel and property losses. That natural hazard caused "returning farmland to lake" (RFL) policy into effect, which made remarkable change of land use such as many cultivated land being change into wetlands.

(2) Anthropogenic factor

During the expert consultation meeting of the project kick-off meeting in Dec. 2011 in Beijing, driving forces was summarized in Poyang Lake wetlands, which included policy, industrialization, urbanization and ecological projection.

According to the land use data, from 2000 to 2013,the area of changed land of Chenlang village, S huanglong village and Yuanlong village is respectively 117.1 hectares, 45.7 hectares and 59.6 hectare s, as the 37.05%, 27.30% and 21.45% of total land area, indicating that the extent of land use change over the past 10 years in these villages was fierce. During the land use / cover change (LUCC) process, the main LUCC is caused by newly built homestead, cultivated land abandon, transformation from paddy field into dry land, fish ponds construction and eco-projects which took more than 95% of the total changed area.Among them, the types of LUCC cause by ecology construction project, in which including the afforestation of barren hill, returning farmlan d to Lake, grain for green, afforestation on wetland under project of returning farmland to Lake, relo cation of homestead under project of returning farmland to Lake.

According to land use/cover data of the typical villages, we had calculated out the area of each LUCC type and its proportion of the whole LUCC. Proportion of the LUCC which caused by ecological project is between 20%--35% (Table 3), and ecological project (RFL and RFF) had made much cultivated land change into forest, grassland and wetlands. In the past ten and more years, urbanization had make large number of young labor force in rural area go to cities, which make labor force in rural become less and the phenomenon of dominance of aged people become more serious. From the household questionnaire survey, of the 125 interviewee 75% of them were between ages of 50—70, only 2. 8% of the interviewee's age was between 30—40, and there were no interviewees who were below age of 30 which caused some low quality cultivated land was abandoned due to insufficient labor forces. In the 3 typical villages, proportion of cultivated land abandoned was between 13%-50%. Under the reason of low comparative benefit of agriculture, in recent years, structural readjustment of agriculture had been very common and possess big proportion in the 3 typical villages, its current LUCC type is fish ponds construction and transformation from paddy field into dry land (used for cash crops such as cotton) . Besides, income

increasing of the farmers in recent years had made new built homestead increased, and there are more than 2 ha new homestead increasing in the past 10 more years. From above analysis, we can get the conclusion that ecological project, urbanization, low benefit of agriculture, and income increasing of the farmers is the most important LUCC driving forces in Poyang Lake wetlands. In addition, from analysis the PRA, stakeholders show that input more inputs (such as more chemical fertilizer) to the good quality cultivated land had made cultivated land use intensified.

Table 3 Type of LUCC and its proportion of the whole land area in the typical villages

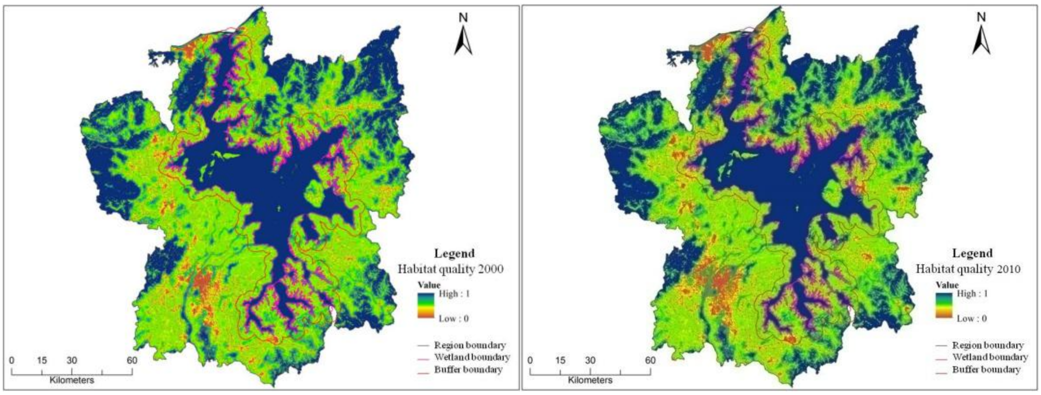
LUCC types	Chenlang Village		Shuanglong Village		Yuanlong Village	
	Area (ha)	proportion (%)	Area (ha)	proportion (%)	Area (ha)	proportion (%)
newly built homestead	2.1	1.8	4.0	8.6	9.0	15.0
cultivation land abandoned	15.5	13.2	26.8	58.6	21.8	36.6
paddy field to dry land	53.0	45.3	4.3	9.5	6.6	11.0
fish ponds construction	20.4	17.4	0.0	0.0	0.0	0.0
LUCC caused by ecological project	26.1	22.3	10.2	22.3	20.1	33.7
Including:1.afforestation of barren hill	2.8	2.4	10.2	22.3	0.0	0.0
2. returning farmland to Lake	6.6	5.6	0.0	0.0	6.1	10.3
3. afforestation on wetland	16.7	14.3	0.0	0.0	5.5	9.3
4. relocation of homestead	0.0	0.0	0.0	0.0	4.2	7.0
5. returning farmland to forest	0.0	0.0	0.0	0.0	4.2	7.1

Data source: Land use/cover survey of the villages in April of 2013

(3) Changes of major ecosystem services in past 20 years

(3.1) Biodiversity

Based on the calculation of InVEST model, in 2000, the average quality of habitat of the whole Poyang Lake wetland was 0.69, and it went up to 0.72 in 2010 with a growth of 4.53%.



a) 2000 b) 2010

Figure 9 Habitat quality of Poyang Lake wetlands

Recognizing the importance of this wetland habitat, the Chinese government implemented "return farmland to lake" (RFL) and "returning farmland to forest" (RFF) ecosystem restoration projects, which began in 1998 and 2000, respectively, leading to the positive effects on the ecological environment (e.g., Li et al. 2009).In our research work, we present the analysis of changes in the habitat quality for overwintering birds based on surveys around two Poyang Lake wetland villages over a 12-year period. We used the ecosystem services analysis tool InVEST and land-use and cover change data to provide an assessment at the levels of the two villages.

The InVEST model produced habitat quality maps for the study villages in 2000 and 2012 (Figure 5). The InVEST model uses a [0, 1] interval to represent the habitat quality for migratory birds, high number represent high quality. The model’s calculations show that the average habitat quality in and around Chenlang in 2000 was 0.48, and that this increased by 18.8% to 0.57 in 2012. This increase in habitat quality can be attributed to the RFL program and discontinuing cultivation of a large area of paddy fields. This resulted in a decrease in the area of habitat with a low score (paddy fields, score = 0.25) and an increase in the area of habitat with a high score (herbaceous wetlands, score = 1). Human activities, such as increasing household and road construction activities, decreased the habitat quality to a certain degree.

For Yuanlong village, the InVEST calculations showed that the average habitat quality increased from 0.44 in 2000 to 0.65 in 2012 (by 47.7%). The increase in habitat area occurred mostly in the northern part of the village (Figure 4), where it was common to discontinue farming, whereas a large increase in habitat quality occurred in the southeastern area, which experienced the effects of the RFL program. This change in habitat quality in the southeast can also be attributed to a change in the human population after 1998. In 1998, the Poyang Lake area suffered from a severe flood, and the government initiated resettlement of the residents. In 2000, households began moving to higher elevations west of the village and the original houses were removed. By the end of 2005, when the project was nearly finished, half of the original settlement had been moved, and this area was covered by trees and grasses. Resettlement moved humans farther from the migratory bird habitat, and the trees and grasses also provided a buffer between human activities and the migratory birds. However, some threats in this area are still being caused by human activities, such as cultivation of dry land and aquaculture, so the quality of the habitat of this area is not much higher than in the northern part (Figure 10).

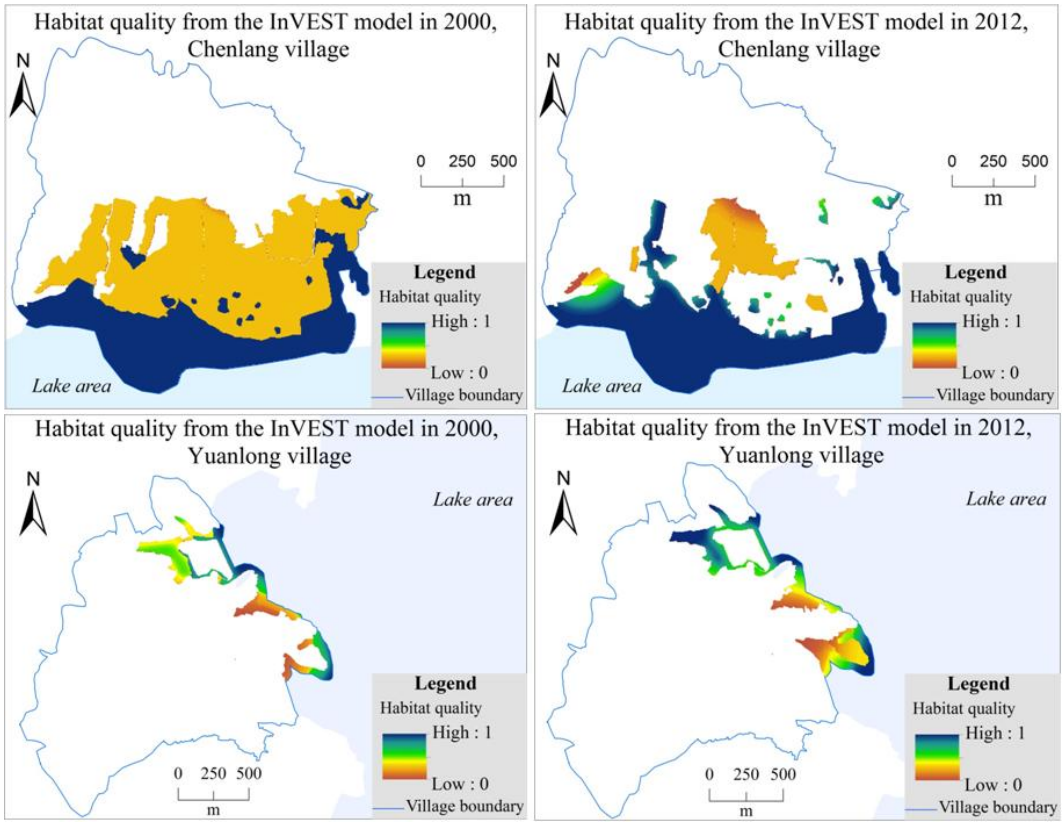


Figure 10 Habitat quality in 2000 and 2012 in and around the two study villages. Higher values mean more suitable habitats.

To show how habitat quality change had affect the species and amount of the migratory birds. We analysis the migratory birds change in Xinmiao Lake (around Chenlang village) and Xihu Lake (around Yuanlong village). Overall, the numbers and percentage of migratory birds that were observed repeatedly or in large numbers near the two villages has increased and the number of some species (e.g., the Eurasian spoonbill, tundra swan, swan goose, and bean goose) has shown an increasing trend (see appendix). However, the number of individuals or the occurrence of a few migratory species has decreased, whereas the numbers and occurrence of the grey heron, greater white-fronted goose, gulls, and other migratory birds have shown no obvious trends. The number of species and population sizes of the migratory birds that were observed in large numbers was higher in Xinmiao Lake (Chenlang) than in Xihu Lake (Yuanlong), and this may be related to the larger total size of the Chenlang area. However, from 2002 to 2012, the numbers and percentages of migratory birds in Xihu Lake were relatively stable, and a variety of birds were regularly observed. The average frequency of the most frequent or abundant migratory birds observed in Xihu Lake was 7.76 times per 10 years, whereas that in Xinmiao Lake was 6.62 times per 10 years. There are two possible explanations for this difference. The first is that habitat quality improved to a greater extent for Xihu Lake during the study period. Second, Xihu Lake has been less affected by human activities than Xinmiao Lake. Especially during the later years, as the ecological environment improved, many critically endangered species, such as the Siberian crane and the oriental white stork, were more regularly observed along the Xihu Lake observation route.

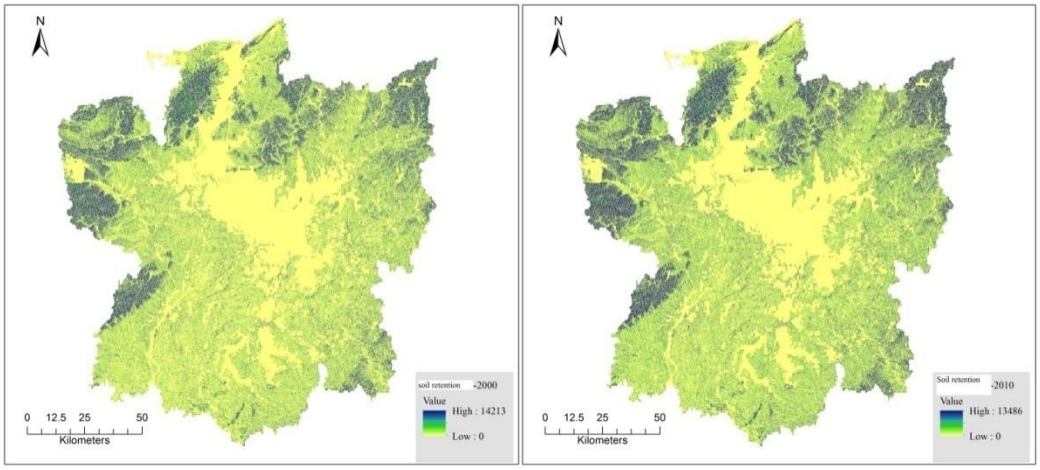
(3.2) Soil retention

On account of the calculation of InVEST model (Table 4), the amount of soil erosion of Poyang Lake wetland decreased from 16.50 Mt in 2000 to 15.45 Mt in 2010 with the amount of 1.05 Mt decreased as 6.39%. According to the equation of soil conservation, the amount of soil erosion is an important parameter to calculate the amount of soil erosion, so the decrease of the amount of soil erosion must lead to the decrease of the amount of soil conservation. Whereas, the amount of soil conservation will be impacted by the land use cover, soil conservation measures and the surface

topography. Comparing the situation between 2000 and 2010, the amount of soil conservation increased 0.28 Mt as 0.02% while the amount of soil erosion decreased which means that the function of soil conservation in Poyang Lake wetland was improved. On the other hand, the sediment output of the Poyang Lake wetland decreased from 1.82 Mt in 2000 to 1.77 Mt in 2010 with a drop of 2.57% which also indicated the improvement of the ability to retain sediment and the strengthen of the function of soil conservation.

Table 4 Changes of the function of soil conservation in Poyang Lake wetland (2000-2010, million ton, %)

	2000	2010	amount change	proportional change
amount of soil erosion	16.50	15.45	-1.05	-6.39
amount of soil conservation	1161.41	1161.70	0.28	0.02
sediment output	1.82	1.77	-0.05	-2.57



a) 2000 b) 2010

Figure 11 Soli retention of Poyang Lake wetlands (ton/ha)

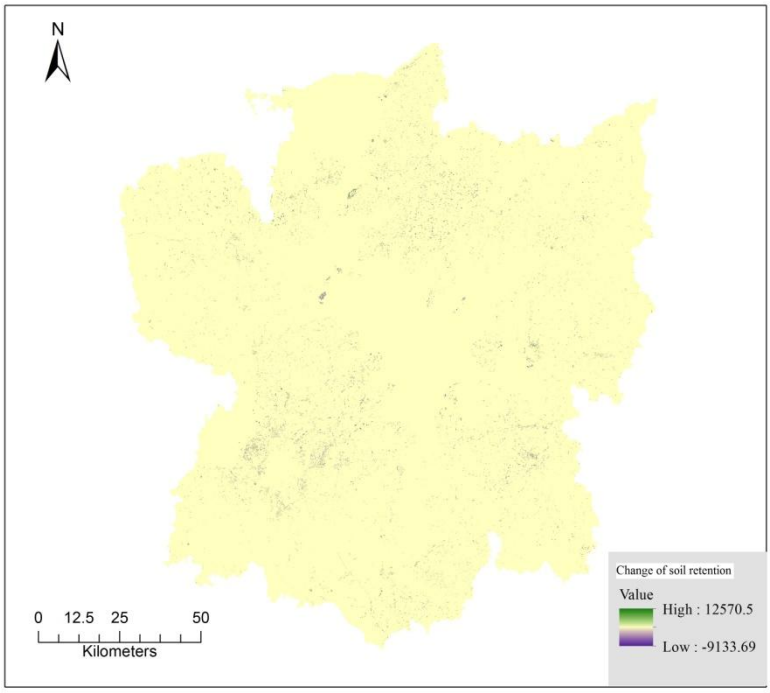


Figure 12 Change of soil retention (2000—2010, ton/ha)

3.1.1.3 Analysis of influence of land use change on ecosystem service change

(1) The effects of land use change on biodiversity

Land has the function to provide habitat. According to experts' weight result on the function of providing habitat from different land type, the forest had the highest weigh as 1, and grassland and wetland had the weight of 0.80 and 0.70, while cultivated land and others got relatively low weight as 0.40.and 0.30. The construction land had the lowest weight as 0.

Table 5 The weight of land use/cover support for habitat

	Forest	Grassland	Wetlands	Cultivated land	Construction land	Other land
weight	1.00	0.80	0.70	0.40	0.00	0.30

During 2000 to 2010, the main cause of Poyang Lake wetland habitat quality rise is that, the Returning farmland to forest made the high weight land use types such as forest and grassland area increased largely (growth rate as 2.1% and 16.4%), even if the cultivated land area increased much. The increase of construction land caused by stress strength enhancement mainly in cities, and for the rural and mountainous area, construction land stress degree is not high, while the agricultural activities reduced after Returning farmland to forest. Therefore, on the whole, during 2000-2010, the Poyang Lake wetland habitat showed the tendency of scale reduction and the rise of quality.

Household questionnaire survey showed the result that within a decade, the vegetation coverage of villages which has close relationship with the habitat quality improved a lot. As to the questions about the vegetation coverage of villages, more than 90% the respondents thought it was increased. The reasons for the vegetation coverage rise can be concluded as that: first, the implement of the return farmland to lake project and returning farmland to forest; second, the phenomenon of cultivated land abandon happened a lot; the improvement of living standards, decrease of household labor with the urbanization and the use of alternative energy sources such as power, liquefied gas with the aging.

For the typical villages, the habitat improvement around Yuanlong village (47.7%) was much higher than that around Chenlang village (18.8%). This difference may have resulted from differences in the change of habitat size and in the impact of threat sources under the joint action of restoration programs and human activities in these two villages. First, the proportion of the habitat with a high score around Chenlang village has increased by only 11.7%, versus 208.1% around Yuanlong village. Chenlang village had planted a large area of fast-growing white poplar in the wetlands created by the RFL project, and the good growth and survival of these trees made the habitat unsuitable for migratory birds. Although Yuanlong village also planted white poplar in its wetlands, the survival rate was very poor and it had little effect on habitat quality. From 2000 to 2012, there were many land-use and cover changes around the waterfowl habitats, which increased the intensity of the threat to waterfowl habitat in Chenlang village; these included changes from paddy fields into dry cultivated land, construction of aquaculture ponds, and construction of residences. In contrast, house demolition in Yuanlong village under the RFL project and the conversion of dry cultivated land into forest under the RFF project caused a substantial decrease in the intensity of the threat to waterfowl habitat. Figure 8 summarizes the main impact factors and their effects on waterfowl habitat in our study villages.

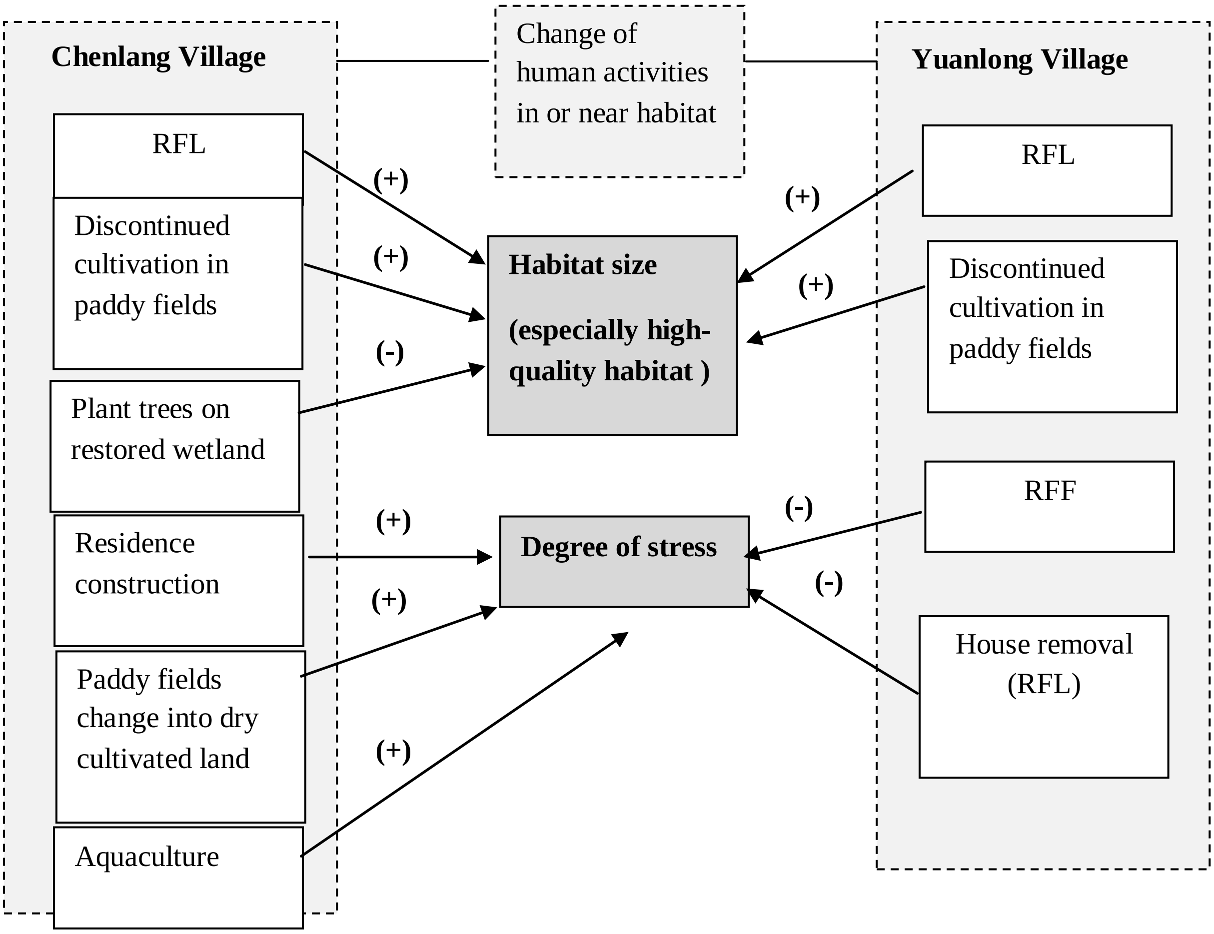


Figure 13 shows the main impact factors that affected waterfowl habitat quality in and near our study villages. Human activities either increased (+) or decreased (–) habitat size, the degree of threat to habitats, and habitat quality. Less important activities are not shown.

(2) The effects of land use change on soil retention

During 2000-2010, because of the implement of returning farmland to forest, the forest with good vegetation coverage and sediment blocking efficiency growth in a large scale (115430.4 ha, 2.1%), and returning farmland to forest, cultivated land abandon and increased area taken by construction land made the relatively low vegetation coverage and sediment blocking cultivated land area decrease sharply (47615.3 ha, 6.3%). Therefore, the soil erosion situation was alleviated and the soil conservation function was reinforced.

3.1.2 Giam Siak Biosphere Reserve in Indonesia

3.1.2.1 Land use change in biosphere reserve

The needs for daily consumption are depend on the ecosystem, and they have to adapt with the environment. In terms of land use change, the villager described that the change of forest, shrub into a rubber plantation are very dominant. Changes in land use are influenced by internal and external factors, namely: (1) the income of farmers from rubber is larger than other sector (2) marketing of products that are easier, (3) experience of crops farming which less profitable, (4) knowledge of farmers on rubber cultivation increased, (5) the suitability of land for rubber trees are very appropriate, (6) labor requirements for rubber farming more efficient, and (7) the cost of production of rubber farming is relatively low, and (8) the risk of failure in production is relatively low. Broadly speaking, the effects of land use change can be seen from the daily life of society, ranging from livelihoods, ecosystem services, the existence of a beneficial plant, to lifestyle changes.

There are some drivers which make the land use change happened; indirect drivers and direct drivers. In Temiang village, the indirect drivers are population change (demographic drivers). In Tasik Betung, the indirect driver is sociopolitical drivers (in Riau, Dutch East Indies government gives orders to build a rubber plantation. In 1864, rubber was introduced and developed in Indonesia). The direct drivers is the habitat changes which driven through land use/cover. In Temiang, the pattern of the land use change is the change of other uses (forest, shrub, open land and fields) into a rubber plantation, fields and road construction, while in Tasik Betung the land use change pattern is the change of forest become plantation.

3.1.2.2 Land Use Types in Temiang and Tasik Betung Villages

Based on the questionaire, 40% respondents of Temiang had rubber field area <2 ha (30 years ago), 35% of respondents answered that they have rubber field area about <2 ha (now). Another 38% of respondents of Temiang answered that they used to have about 2—3 ha rubber field area (30 years ago); 40% respondents have 2—3 ha (now); 15% of respondents have 3—4 ha rubber field area (30 years ago); 15% of respondents have 3—4 ha rubber field area (now); and 7% of respondents have 4—5 ha rubber field area (30 years ago); 10% of respondents have rubber field area (now) (Figure 14).

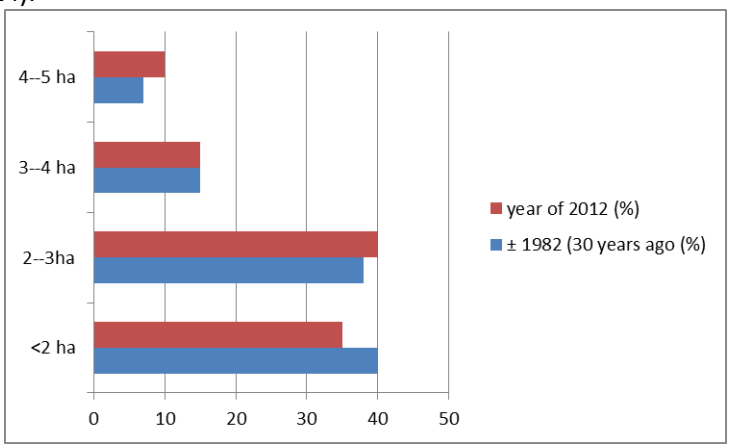


Figure 14 Rice Field Area in Temiang village

Based on the questionaire, 40% respondents of Tasik Betung had rubber field area <2 ha (30 years ago), 20% of respondents answered that they have rubber field area about <2 ha (now). Another 28% of respondents of Tasik Betung answered that they used to have about 2—3 ha rubber field area (30 years ago); 15% respondents have 2—3 ha (now); 22% of respondents have 3—4 ha rubber field area (30 years ago); 20% of respondents have 3—4 ha rubber field area (now); and 10% of respondents have 4—5 ha rubber field area (30 years ago); 45% of respondents have rubber field area (now) (Figure 15).

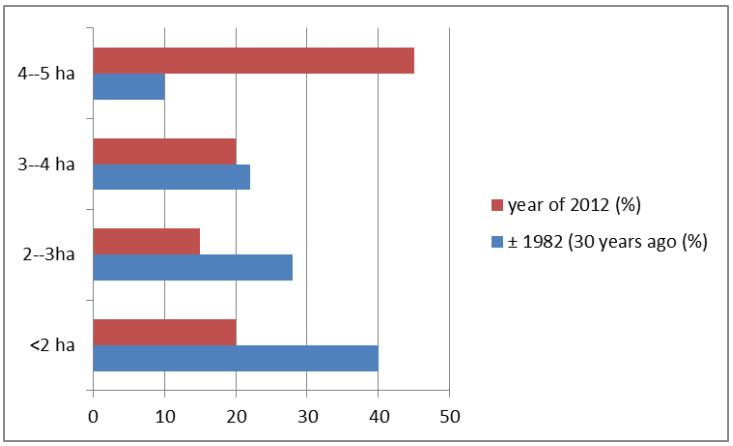


Figure 15 Rubber Field Area in Tasik Betung village

Based on the questionaire, 30% respondents of Temiang had oil palm field area <2 ha (30 years ago), 10% of respondents answered that they have oil palm field area about <2 ha (now). Another 25% of respondents of Temiang answered that they used to have about 2—3 ha oil palm field area (30 years ago); 30% respondents have 2—3 ha (now); 20% of respondents have 3—4 ha oil palm field area (30 years ago); 15% of respondents have 3—4 ha oil palm field area (now); and 25% of respondents have 4—5 ha oil palm field area (30 years ago); 25% of respondents have oil palm field area (now) (Figure 16).

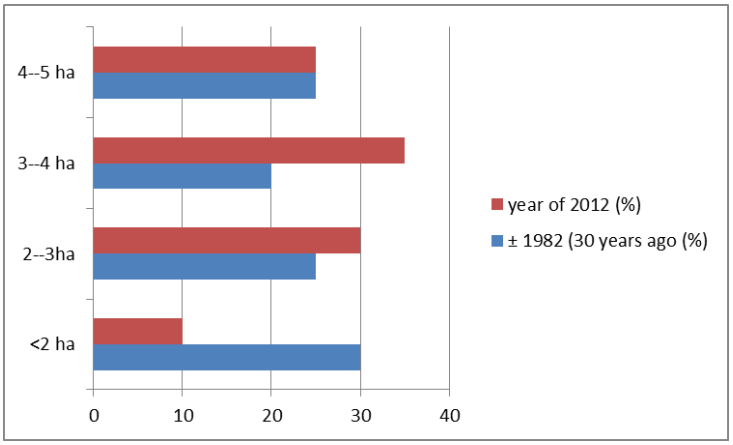


Figure 16 Oil palm Field Area in Temiang village

Based on the questionaire, 40% respondents of Tasik Betung had oil palm field area <2 ha (30 years ago), 5% of respondents answered that they have oil palm field area about <2 ha (now). Another 37% of respondents of Tasik Betung answered that they used to have about 2—3 ha oil palm field area (30 years ago); 15% respondents have 2—3 ha (now); 20% of respondents have 3—4 ha oil palm field area (30 years ago); 34% of respondents have 3—4 ha oil palm field area (now); and 3% of respondents have 4—5 ha oil palm field area (30 years ago); 46% of respondents have oil palm field area (now) (Figure 14).

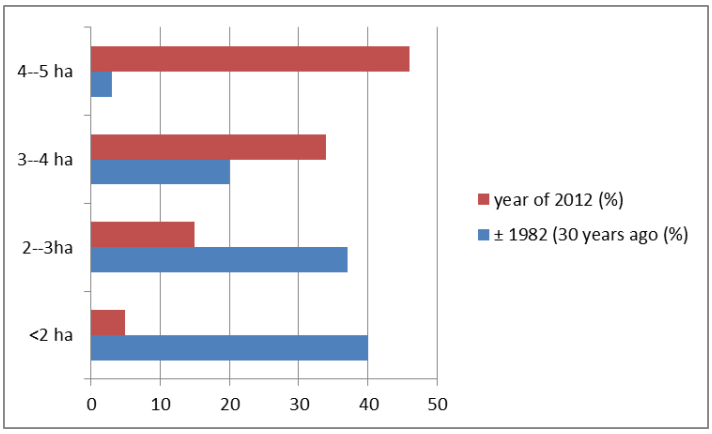


Figure 17 Oil palm Field Area in Tasik Betung village

3.1.2.3 Land Use change analysis by GIS method

Data obtained from the extraction is then displayed in a table showing the changes in land use, respectively (Table 6). Table 6 shows the declining of extent in some types of land use such as primary swamp forest (13.43%), plantation (9.51%), and secondary dryland forest (0.51%). In addition, it is also indicate that some of land use types, namely increased swampy shrub (5.15%), plantation forest (6.88%), and Settlement (0.02 %)

Table 6 Change in Land Use Area in the Giam Siak Regency

Type of Land Use	Land Use Area (Ha)		Percentage Rate of Land Use Change (%)	Notes
	In 2000	In 2012		
Swampy Shrub	30062,26	115600,60	5,15	Increase
Secondary Dryland Forest	9292,61	737,36	0,52	Decrease
Secondary Mangrove Forest	292,05	291,70	0,0000213	Decrease
Primary Swamp Forest	248015,45	25082,19	13,43	Decrease
Secondary Swamp Forest	524398,74	463752,55	3,66	Decrease
Plantation Forest	49697,20	163908,22	6,88	Increase
Seaport & Airport	79,16	79,06	0,0000058	Decrease
Plantation	537868,96	380043,67	9,51	Decrease
Settlement	12423,14	12836,44	0,025	Increase
Mining	16306,04	16203,04	0,006	Decrease
Dryland Farming	43248,76	26022,81	1,039	Decrease
Dryland Farming with shrub	31048,72	31230,32	0,011	Increase
Swamp	1907,58	2000,59	0,0056	Increase
Paddy field	15735,36	15718,10	0,001	Decrease
Bush/Shrub	101193,62	80230,19	1,26	Decrease
Fish Pond	38,39	38,35	0,0000028	Decrease
Open Area	28034,44	44332,16	0,98	Increase
Water Area	9815,16	9803,29	0,0007156	Decrease

The data was shown from Tabel 1 described the land use change pattern during the period of 2000 – 2012 in Giam Siak Regency. These pattern informed us that the primary and secondary swamp forests decreased about 13.43 and 3.66%, respectively during the period of 12 years. Plantation forest increased about 6.88% during 12 years. Decrease of forest area significantly affect to the biodiversity loss, and endemic species as well.

These picture (Figure 18 – 22) are the landuse change Map in the Giam Siak Regency from 2000 – 2012.

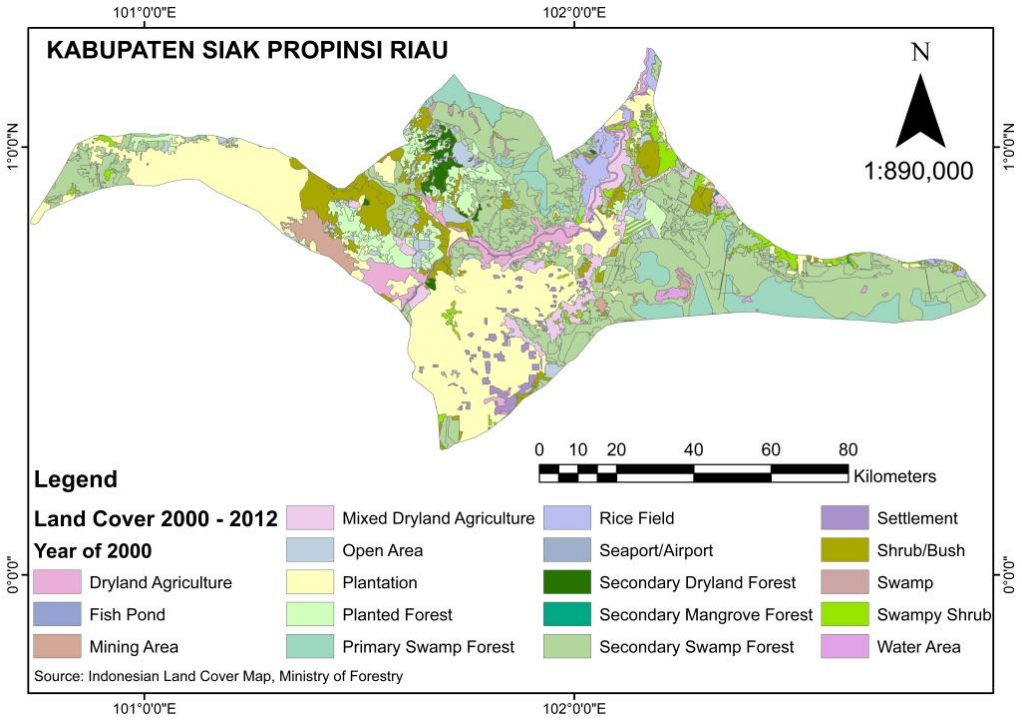


Figure 18 Land Use Area of Kabupaten Siak in 2000

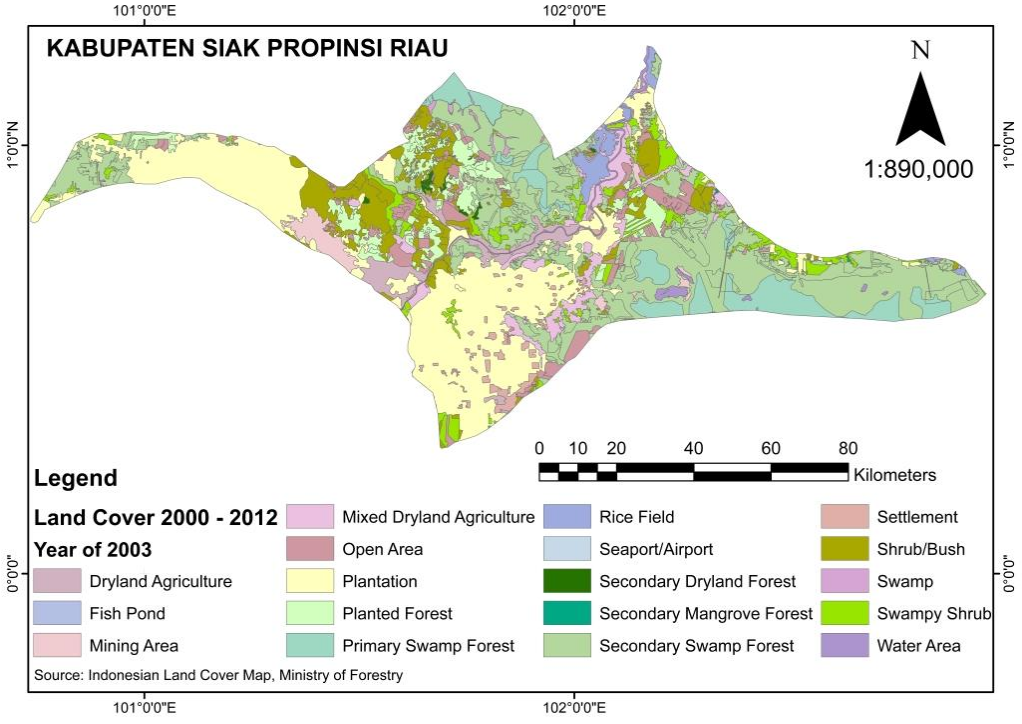


Figure 19 Land Use Area of Kabupaten Siak in 2003

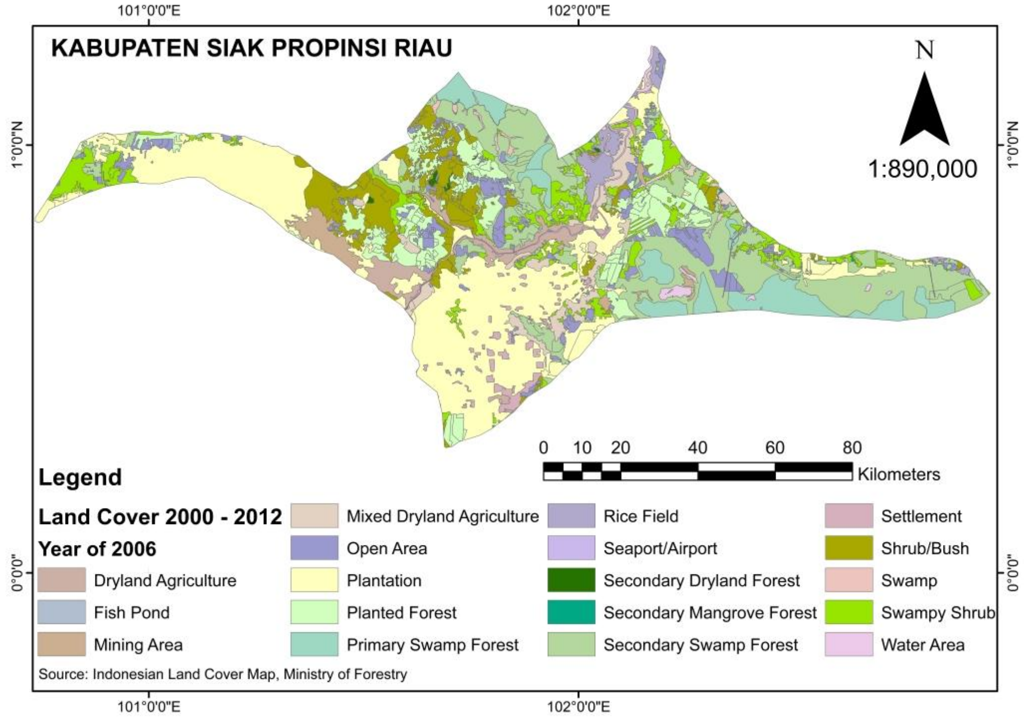


Figure 20 Land Use Area of Kabupaten Siak in 2006

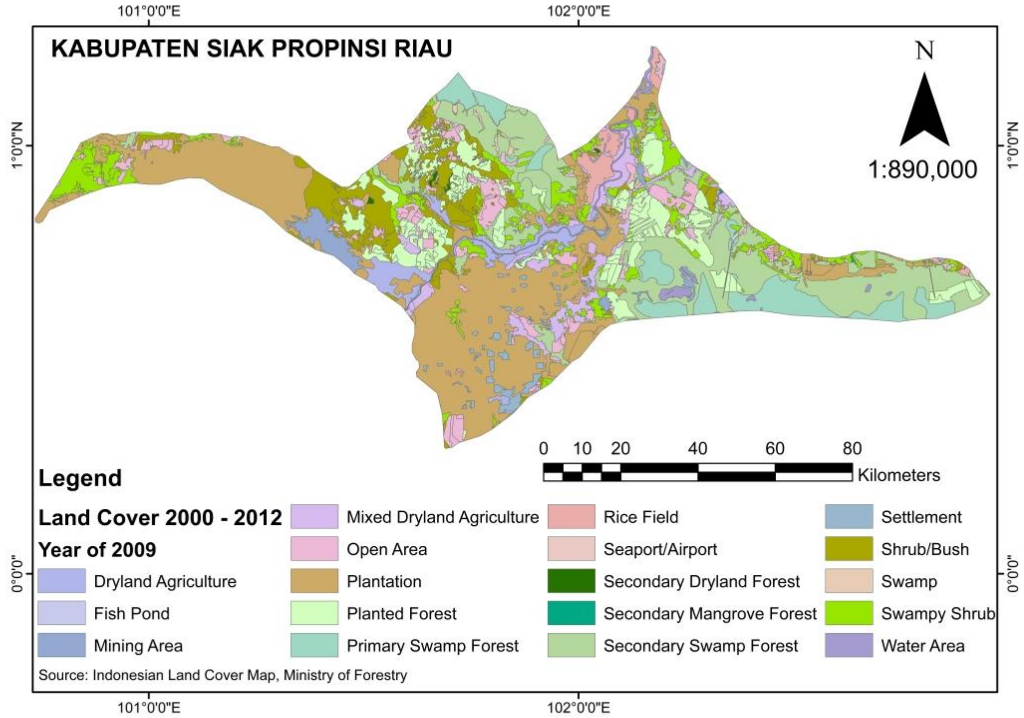


Figure 21 Land Use Area of Kabupaten Siak in 2009

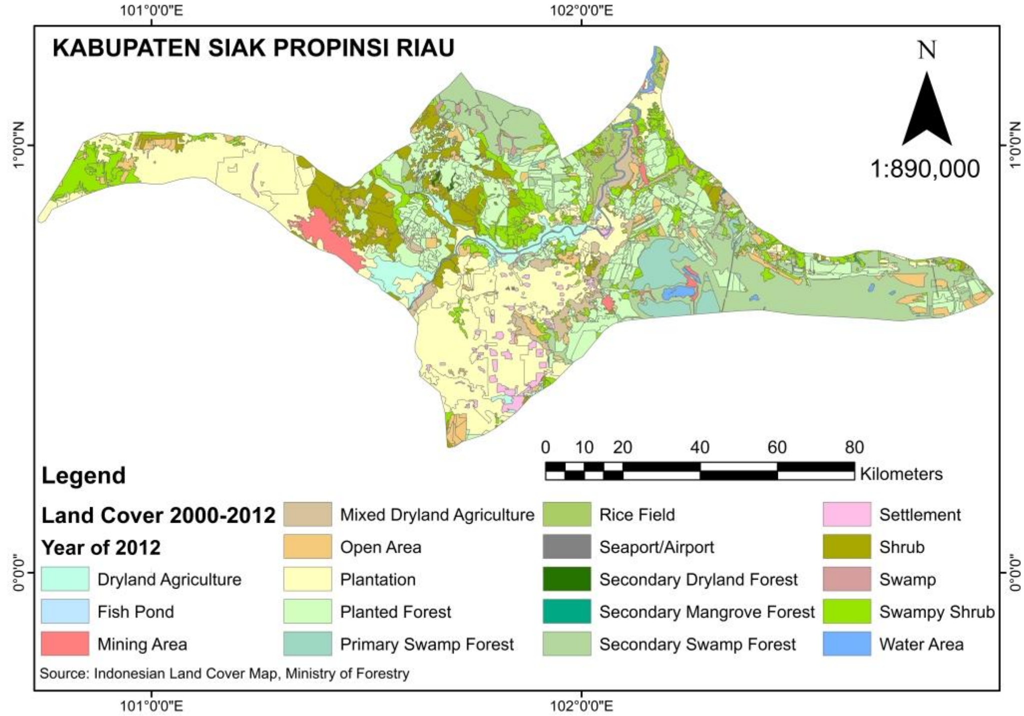


Figure 22 Land Use Area of Kabupaten Siak in 2012

3.1.2.4 Land Use change in the Temiang Village

The figure below are the land use change in Tasik Betung village from 2000 – 2012. This is not easy to make the illustration of the village condition while they were young. From the FGD, There are three schenario of Map: 1980 (Above, left), 2012 (Above, right), and the future map (below map), the map which described the ideal condition for the villager.

(1) Land use in Tasik Betung village

Figure 23. Land Use change in the Temiang village. From the Map those were described by local people, the forest decreased from 1980 to 2012, oilpalm and rubber plantation develop. While in the future, the village condition well organized than 1980 and 2012.

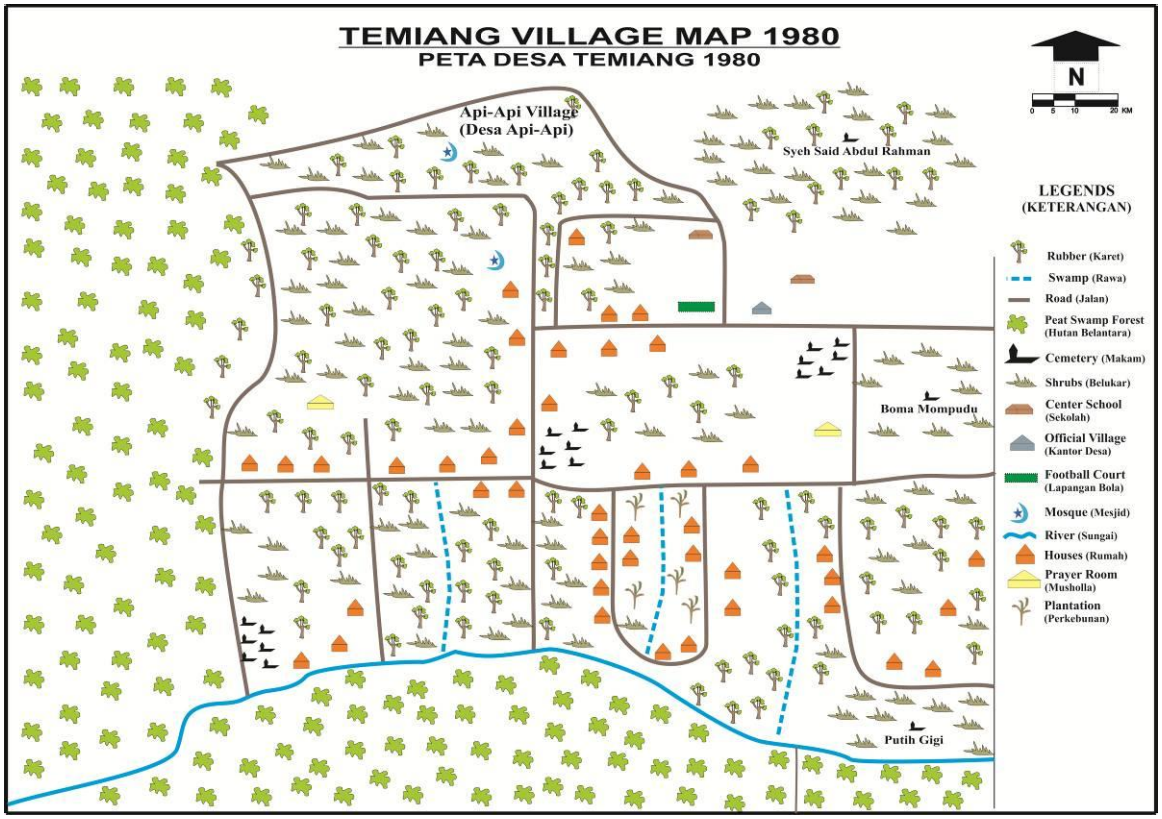


Figure 23 Temiang Village map in 1980

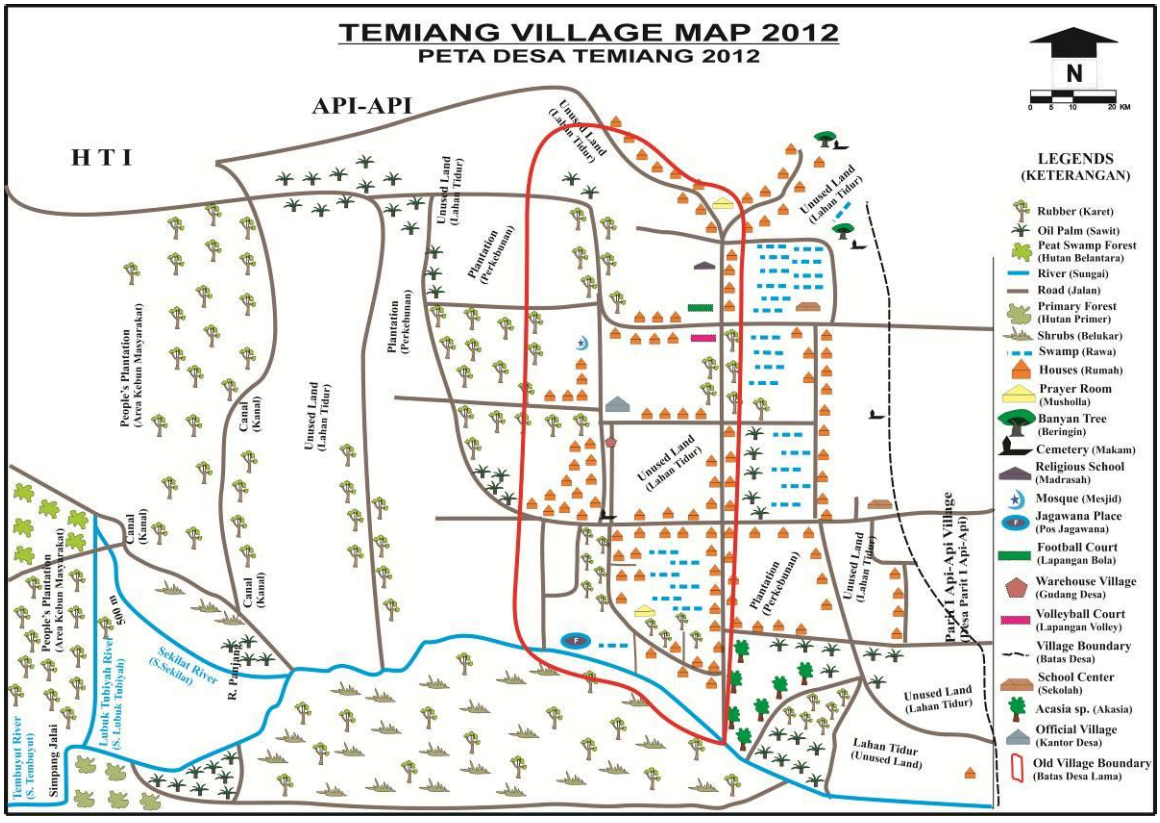


Figure 24 Temiang Village map in 2012

In the future, Temiang people also wants some changes in their village, most of the changes related with the village facilities, such as school for children in early age (PAUD), rice mill, sport building, and more mosques. Also they want have a clean water tower to canalize water to the

village. The people also want a rejuvenation in the plantation and the seed distribution of Forest Tree Nursery Care Community Forest Group (Persemaian Tanaman Hutan Kelompok Masyarakat Peduli Hutan).

3.1.2.5 Driving forces of land use changes

Every year, population growth in study area is increasing. In 2001, the members of Tasik Betung village are 221 people. Men are 105 and women are 116 people (BPS 2001). The members of village in 2012 are 437 people, Women are 208 and men are 229. Along with population growth, people need many lands for house, road, garden, plantation, and agriculture. Those are the reason land use change in Tasik Betung and also Temiang. Land use change is a complex problem because there are so many factor affecting. For political perspective, Indonesia has three kinds of elections; local (regency and local parliament), regional (governor and regional parliament), and national (president and national parliament). In campaign session, some politician promise will give lands to people if villagers give vote for his in the local election and he becomes the regent, change the regulation and people will has property right the land. Social-cultural perspective, along with social change then values in local people also had changed. Currently, people doing something in the past are forbidden. Besides that, materialism or orientation to material is more important than values. Economic perspectives, along with increasing the welfare when people have money they will buy anything, mainly land. One villager has many lands in different location.

3.1.2.6 Impact assessment of land use changes

(1) Changes in livelihood and environment product

From the questionnaire, we know that most of the attendees worked as a farmer and most have last education in High School (40%). The other people have last education in Elementary School (9%), Beginner school (38%), and others (13%). Also, the community is no longer raising fish or relies on the forests, but more work in the agricultural sector.

From the results of a questionnaire obtained that the community acquired the construction tree such as meranti (Shorea sp.) wood. Nowadays, this type is still can be found, and people also use gerunggang (Cratoxylum arborescens) for construction. In addition to wood building, up to now people also benefit from the plants as food additives which are cassava, palas (Licuala spinosa), and samak (Syzygium chloranthum). They also get the benefit from drugs such as mahang (Macaranga triloba), turmeric, ginger, piper, palas (Licuala spinosa). Palas (L. spinosa) is one of the plants that have two functions, for food and construction. Fruits can still be found today as nangka (Artocarpus heterophillya), rambutan (Niphelium lappaceum L, and coconut. Plants for handicrafts are asau, umbai, and rattan, but rattan is rarely found, which still used are umbai and asau

In terms of usage and water resources, Temiang people use water from rain and wells for cooking, farming, washing, and drinking. Rain water and wells become more widely used as source of water for the community. The loss of open areas reduced the absorption area, so that the community would have to find other sources of water, i.e. rain water and make a wells. In terms of knowledge about climate change, couls be described that most people know about climate change (40%). They argue that climate change is a change in the weather (37%), while climate change is a change in rainfall (20%) and temperature changes (3%). Change in weather effects in pattern of planting and harvesting.

In Tasik Betung, based on the questionnaire, most respondents work as farmer 85,2%, about 7,4% of people work as plantation workers and the other job is 7,4%. Most respondents have education background in Beginner School (SD) 63,0%, 18,5% in Elementary school and 7,4% respondents' background study is Senior High School. Most people have income resources from rubber plantation 19%, rice plantation or selling rice 8%, wood from forest 8%, fruit from forest is 5%, fisheries is 2%, vegetable selling is 5%, rattan selling is 11%, and the other people work as government official, driver, worker, and raising chickens (34%). There are 27 respondents (60%) who had selling the

rubber, which is about 40—50 kg, 40% respondents had selling 40—50 kg rubber. In rattan production, 18% respondents answer that they have experience in selling 1-2 ton of rattan production and 13% respondents answered that they sell 2-3 tons of rattan production.

In term of water resources usage, all respondents of Tasik Betung answer that they use rain water for cooking, washing, and bathing. Every household has wells. The depth of wells depends on the climate. In the rainy season, water is abundant but in the summer the water began to decrease. In 2011, when the research is conducted, 35% of respondents answered that they feel the climate also affecting on the well. 25% of respondents answer that it is not affecting, and the other 40% respondents answered 'no comment'. They know that climate affects to the wells mainly when they find it difficult to make the new wells and the decrease of the water wells in dry season.

(2) Changes in Income Sources and Infrastructure

From the questionnaire can be seen that for the last twelve months Temiang people earn income from planting rice, rubber, and palm tree. In addition, the society also received the result of breeding chicken, cows and pigs. Other jobs are self-employed, Government employees and private business. This show the changes in livelihood, which was reared fish and tend to live in the forest, now no longer. For flood frequency, it can be seen that before the year 2000, the majority stated that there was flood once in Temiang, so also after the year 2000.

In terms of infrastructure, the land use change also push changes in infrastructure. In Temiang people began to have motorcycle, before that traffic can only be traversed by rivers, so they have to rent or have a small boat. Road construction is also a cause of changes in land use, rubber and palm oil plantations need a way to transport the crop, based on questionnaires, the highway is now also more develop. It makes easier for people to go to another place. Transportation and infrastructure make Temiang people become easier in doing activities and obtaining a new lifestyle, such as the ownership of mobile phone. Mobile phone became a significant item in village of Temiang. So is the case with television, the public want to know more and wider information through television, seen from the increasing number of people who have a television, radio has begun otherwise abandoned.

The house in Tasik Betung village was once made of wood, the floor is made of durian leather, the wall is made from meranti wood, and the roof is made from kepau (Pothos latifolius) trees. The houses do not use nails but using rattan which is tied. Ceiling was not as high as it is now, but only as high as the head; the distance between the houses to the other house is 500 m. The house in the village is consisting of courtyard and the room. The courtyard could be located in front or behind the house. This courtyard is use for plant some herbs or plants that can be used for food addition. Behind the house can also be a place for breeding fish. The number of rooms in the house is usually made as needed.

In terms of room placement, typically, parents occupy the forefront of the first room, followed by the children's room. If they have a daughter, then the daughter will occupy in the room was next to the parents' room. If they have children consist of boy and girl, the girl will be placed in the middle between the parents and the boy. It aims to protect his daughter, because girls usually have to be more protected. If they do not have the room, it is not a problem for the parents, and the most important is that they have a place to be a shelter. Now, it is common to make more rooms because each member of the family wants some more privacy in their life.

There are some ecosystems that are known by Temiang people; the fields, rice fields, garden, unused land, and forests. The field is a land that can be planted for anything, whereas field rice is only planted with rice. Garden is planted with a variety of plants that can produce crops that are considered like rubber and nuts. Unused land is commonly owned by people land and has not received a specific activity. In addition, people have also distinguished fields and rice paddies in their mention. Fields and rice paddies are basically alike grow rice, but with different process, and it makes them so different. The field opened it by slashing the trees, then burned and planted rice, to open fields, the land will be plowed, then crushed the grass and planted rice. In terms of irrigation, fields have more regular system. In this village more paddy fields are found. People are also familiar with the term forest and shrub forest, forest is an area consists of a large timber and has not been

processed, while the shrub is filled with a large timber.

According to Temiang people, field can be planted anything, it is different from paddy field that only planted with rice. According to people, garden is land that can be planted with beans and rubber. Unused land is owned by people and has not been processed. This land is fulfilled with shrubs. Besides rubber plantations, people also make changes to the land that became the paddy fields, by shifting cultivation or slash farm. After the land was burned, rice was sown by using a drill that almost does not cause damage to the soil. If firing is successful and it rained quite a lot, they will get good results.

According to Tasik Betung people, settlement is an important thing. The orientation of settlement pattern is close with forest and tasik. It shows that people considerate natural factor. Forest and tasik are always provide all human need and everyone can access. The peat land is used by people for agricultural. In the past, when they should survive, people used the peat land for shifting agriculture. In doing shifting agriculture, people in Tasik Betung chose the land is not far from the settlement. For Tasik Betung people, house is just a place for rest when they work on the fields and a transit for one field to other field. So, the location of settlement is always in the center of the field. People calls the models of settlement is 'tapak lapan' or 'eight of ways their activities'.

(3) Land use change impacting to human life

In Tasik Betung, land use change impact to their access to fresh water, fire wood, and biodiversity. While even have the Sacred forest, this forest was not well function as water resources. The sacred site only providing medicinal plant. Decrease of the forest cover impact to the water and biodiversity lost, subsequently will affect to the people health and income.

Be compared with 20 years before, currently local people is difficult to access fresh water. They should walk more far to meet fount. In food security, after land use change local people depend to the market to get food, 20 years before they still got the food for forest, lake, river, etc.

Land use change also impact to the decreased of fish and another natural product. Currently, local people much more difficult to find medicinal plant. Fortunately, the people in Tasik Betung still have sacred forest those provides medicinal plant. Another impact of the land use change is new kind of disease was found, which was not be found before.

3.1.2.7 Impact of land use change on ecosystem services

(1) Impact on useful Species

There are some species used by Temiang and Tasik Betung people, which served as food, medicine, crafts, and building materials (Table 7 & 8).

Table 7 The list of plant used for food, medicine, craft and wood in Temiang Village

Local Name	Species	Family	Used Part	Uses
Bakung	*Hanguana malayana* (Jack.) Merr.	Flagariaceae	Leaf	Vegetable
Asau	*Pandanus* sp.	Pandanaceae	Leaves	Use for making mat
Umbai	undet		Leaves	Use for making mat
Daun nasi	*Syzygium antisepticum* (Bl.) Merr. & Perry	Myrtaceae	Fruit	Food
Daun putat/brasan	*Barringtonia scortechnii* King.	Lecythidaceae	Fruit & wood	Food & firewood
Tengek burung	*Symplocos conchichinensis* (Lour.) Moore	Symplocaceae	Fruit and wood	Bird food and fire wood
Meranti bunga	*38Shorea* sp.	Dipterocarpaceae	Wood	Building material

Local Name	Species	Family	Used Part	Uses
Kranji	*Dialium indum* L.	Fabaceae	Fruit	Food
Kayu malas	*Licuala spinosa* Thunb.	Arecaceae	Wood	Firewood and materials for ompon.
Daun edan	*Paranephelium xestophyllum* Miq.	Sapindaceae	Fruit	Food
Kayu palas	*Licuala spinosa* Thunb.	Arecaceae	leaves	vegetables
Kayu kempas	*Dialium indum* L.	Fabaceae	Wood	Wood for building materials
Asam kandis	*Xanthophyllum ellipticum* Miq.	Polygalaceae	Fruit and seed	Leaves ate for vegetable and fruit used for seasoning
Kayu arang-arang	*Diospyros diepenhorstii* Miq.	Ebenaceae	Wood	firewood
Kayu pacat	*Baccaurea javanica* (Blume) Mull. Arg	Clusiaceae	Wood	The wood is used for house material
Kayu mahang	*Macaranga triloba* (Blume) Mull. Arg	Euphorbiaceae	Leaves	Leaves is mixed with water then rubbed to cure fever
Medang petimah	*Neolitsea cassiaefolia* Bl.	Lauraceae	Leaves	Mixed with nyuang-nyuang hua laves, pulang darah leaves, and pagar-pagar leaves, squeeze and subbed to whole part of body.
Pisang	*Musa* sp.	Musaceae	Young stem	The stem cut in five parts, mixed with water then rubbed to whole body to cure fever.
Gambir	*Uncaria gambir* Roxb.	Rubiaceae	Tuber	Mixed with areca nut, piper then put in water, if the colour of water become yellow, it means there is no fever, if the colour become red, it menas that it is fever.
Terong	*Solanum melongena*	Solanaceae	Fruit	The fruit was heated then put on tooth to cure toothache.

Table 8 Medicinal plants and the uses of plant in Tasik Betung.

No	Local name	Scientific name	Used part	How to use	Utility
1	Kepayang	*Scapium macropodum*	Fruit	Immersed and mix with sugar	fever
2	Petolo bumi	*Eurycoma* sp.	Root	boiled	Weary
3	Balik angin	*Molotus paniculatus*	Leaf	Leaf crushed in water	Urine have yellow color
4	Bulum bayam	Rubiaceae	Fever	Mixed with water and leaf crushed then smeared	Fever
5	Lio	Zingiberaceae	Rhizome	Buffed and boiled	Rhematic
6	Sakat		Leaf and umbut	Ingredient	Stomach acne
7	Segolumon		Leaf	Mixed with	Stomach acne
8	Lada hutan		Root	Mixed with water and leaf crushed then smeared	against the poison in blood
9	Gayat		Leaf	Mixed with water and then drink	Against the poison body
10	Kondung duduk		Root	Crushed and the water for oiled	Against the poison in bone
11	Pulang daâ€™ah		Leaf	Linniment	Against the poison in muscle
12	Mahang ketah		Leaf	Linniment	Against the poison in brain
13	Akar sekasap		Leaf and stem	Linniment	Against the poison in bone marrow
14	Aubulu		Root	Boiled	laryngitis
15	Modang besi		Leaf	Bandage	Stomach acne
16	Akar semelit		Root	Boiled	constipation
17	Katur		Root and leaf	Boiled and bandage	*Kuo* (stomach acne, leaf side)
18	Sondu-sondu		Root	Bandage	*Kui* (stomach acne, right side)
19	Melembayam		Stem	Boiled	Head acne
20	Gedebu		Water in the stem	For bath	Fever
21	Setambal		Root	Mixed water and drink	Cough
22	Ketai bulan		Umbut	Boiled and drink	Pain urinating
23	Mahang putih		Leaf	Boiled and drink	appetite enhancer
24	Anau-anau		Root	Rubbed	Negative element from nature

No	Local name	Scientific name	Used part	How to use	Utility
25	Dalo		Leaf	Rubbed	Shivers
26	Loban		Bark	Boiled and drink	Body illness
27	Kendudu		Root	Boiled and drink	Bloody cough
28	Semboyo		Root	Boiled and drink	Diarrhea
29	Tampui		Root	Boiled and drink	Cough
30	Bahang-bahangan		Leaf	Crushed and drink	Cough
31	Ketupat lombi		Fruit	Mixed water and drink	Body illness
32	Beras-beras		Leaf	Bandage	Head acne
33	Salang-salang		Leaf and root	Leaf kneaded by hand in water and then drink the water	Queasiness
34	Takala antu		Leaf	Leaf kneaded, be heated and then rubbed	Shank acne
35	Tapak gajah		Leaf	Leaf kneaded, be heated and then rubbed	Foot acne
36	Jungjuang hutan		Leaf	Leaf kneaded in the water and then rubbed to body	All the body is sick
37	Paru-paru		Leaf	Leaf pounded and then rubbed	lumbago
38	Pagar-pagar		Leaf	Buffered	Ear acne
39	Ibu-ibu		Leaf	Leaf milled and heated and the leaf water buffered	Ear swelling
40	Ambai ayam		All	Boiling and the water for body wash	After childbirth
41	Kaneh		All	Boiled and the water for body wash along three days	Problem with stomach
42	Dukung anak		All	Boiled and the water for body wash along three days	Fever after going to forest
43	Tampui setambun		Leaf	Buffered	Cough and blown
44	Pinang-pinang		Leaf	Leaf kneaded in the water and then rubbed to body	Sick in muscle

No	Local name	Scientific name	Used part	How to use	Utility
45	Meranti ambai		Leaf		Fever, always have nightmare
46	Kedongdong hutan		Leaf	Leaf kneaded in the water and then rubbed to body	itchy rash
47	Tomeh-tomeh	Zingiberaceae (kunyit)	Leaf	Leaf kneaded in the water and then rubbed to body	Fever
48	Setambal		Stem		Itchy rash
49	Pendarahan		Leaf	Leaf kneaded in the water and then rubbed to body	Foot swelling
50	Setopih		Leaf and bark	Mixed	Sick between bone and flesh
51	Semuat utan		All	Mixed	Sick between bone and flesh
52	Tongkat nabi		All	Mixed	Sick between bone and flesh
53	Tulang tiga		Leaf	Mixed	Sick between bone and flesh
54	Antui		Flower	Sown in the ritual	Traditional medicine ritual
55	Gandarusa		Leaf	Kneaded	Head acne

The plant utilization between two villages show that two kind of village; first (Tasik Betung) is more inland that Temiang. Second, the Tasik Betung people have more intensive interaction with forest than Temiang people. Third, Tasik Betung people still have traditional ritual. The questionnaire of Tasik Betung shows that almost all respondents said that the land use change has no effect, especially to medicine because the Bomo (shaman) and Imbo Botung always provide all the medicinal plant. The land use change effect to fisheries, paddy field, rubber plantation, and cultivation.

(2) Biodiversity in temiang village

The increase the number of people each year requires increasing extents residential areas and fields for planting. This has caused many forest areas have converted to residential areas as well as agricultural land or plantations. This degradation process resulted in the loss of some kind that may be useful to humans.

Preventive efforts against loss of endangered or endemic species are done by promoting conservation. One is the establishment of conservation areas like wildlife sanctuaries and nature reserves. One of the fairly large roles in the biosphere reserves are established in several parts of Indonesia. Until now, Indonesia has had seven biosphere reserves established by MAB-UNESCO.

Giam-Siak Biosphere reserve is a biosphere reserve that is still have close contact with the local population. This can lead the degradation of this biosphere reserve. The research was conducted in order to determine the biodiversity found in the area of the reserve-Giam Siak as a result of the rate of change of land use.

To do the biodiversity assessment, we established the permanent plot on July, 2nd to 8th, 2012 in

the area of the Biosphere Reserve of Giam-Siak, Riau. The plot is close to Temiang village and is located at 1°23'53.3" N and 101°54'17.2" E, at altitude of 375 meters above sea level.

The permanent plot size was 100 m x 50 m. The plot was divided into sub-plots with the size of 10 x 10 m. Observations were made to the conditions of the constituent type, diameter, tree height and canopy projection. Tree with the girth (≥ 15 cm) at breast height (GBH ± 130 cm) was measured to estimate the Important Value (IV). The measurement also been done to the tree with a deep taproot above the forest floor. Trees with stems branching from the ground, all stems with round ≥ 15 cm were measured as different individuals. Plants under the canopy surface were observed, and canopy closure was drawn.

Tree species in the plot observation were collected for herbarium specimens to identify tree species. In addition to collecting sample of plants, the documentation is also done, especially for plants which are flowering or fruiting.

(3) Forest stand conditions

The results of observations indicated that there was change of the settlement in the Temiang Village which is near to the location of biosfer Giam-Siak Biosphere Reserve. Stand in the observation plot is secondary stands as a result of the succession process that occurs when the area of the reserve had a fire experiences.

The field survey of the ecological study in the Temiang Village reported that the tree species were recorded for 498 trees, which were belongs into 29 species and 20 families. These species were only 15% of the total species those were recorded in the Giam Siak Biosphere Reserve report with the total species were about 200 species (Anonim, 2008). From the field survey, the distributions of tree class diameter were divided into: I (4-13 cm), II (14-23 cm), III (24-33 cm), IV (34-43 cm), and V (≥ 44 cm). The highest tree distribution was in the range of diameter 4 to 13 cm, this condition could be described that the pole stage more dominant in this study site. Trees with the class distribution ≥ 44 cm were only recorded for 15 individuals.

The forest fire was broke out in the Giam Siak Biosphere Reserve, this supported the forest succession. This was characterized by the high trees in class diameter among 4-13 cm. This was also indicated by the inverted J shape curve from the distribution of class diameter (Daniel, et. al., 1979). The dominant species in the study site were recorded for Cryptocarya cf. Teysmanniana Miq., Ganua motleyana (de Vriese) Pirre ex Dub., Shorea sp., Dialium indum L., Syzygium clavatum (Kort.) Merr. & Perry., Acronychia pedunculata (L.) Miq., and Symplocos conchichinensis (Lour.) Moore. Shannon-Wienner Index showed that the biodiversity in the observation plot was low.

Table 9 List of Species in Research Plot

No.	Family	Species
1	Rutaceae	*Acronychia pedunculata* (L.) Miq.
2	Clusiaceae	*Baccaurea javanica* (Blume) Mull. Arg
3	Lecythidaceae	*Barringtonia scortechnii* King.
4	Lauraceae	*Cryptocarya* cf. *teysmanniana* Miq.
5	Lauraceae	*Cryptocarya infectoria* (Bl.) Miq.
6	Fabaceae	*Dialium indum* L.
7	Ebenaceae	*Diospyros diepenhorstii* Miq.
8	Melastomataceae	*Dissochaeta bracteata* (Jack.) Blume
9	Bombacaceae	*Durio zibethinus* Murr.
10	Sapotaceae	*Ganua motleyana* (de Vriese) Pirre ex Dub.
11	Clusiaceae	*Garcinia* sp.
12	Clusiaceae	*Garcinia xanthochymus* Hook. F. Ex T. Anderson
13	Ochnaceae	*Gomphia serrata* (Gaertn. Kams.

No.	Family	Species
14	Dipterocarpaceae	*Hopea* sp.
15	Myristicaceae	*Knema furfuraceae* (Hk.f. Et Th.) Warb.
16	Arecaceae	*Licuala spinosa* Thunb.
17	Lauraceae	*Litsea* sp.
18	Anacardiaceae	*Mangifera* cf. *foetida* Lour.
19	Anacardiaceae	*Mangifera* cf. *indica*
20	Myrtaceae	*Melaleuca leucadendra* (L.) L.
21	Sapotaceae	*Palaquium macrocarpum* Burck
22	Rubiaceae	*Plectronia* cf. *conferta* Val.
23	Dipterocarpaceae	*Shorea* sp.
24	Malvaceae	*Sterculia foetida* L.
25	Symplocaceae	*Symplocos conchichinensis* (Lour.) Moore
26	Myrtaceae	*Syzygium acuminatissima* Merr. & Perry
27	Myrtaceae	*Syzygium clavatum* (Kort.) Merr. & Perry
28	Rubiaceae	*Timonius wallichianus* Val.
29	Myrtaceae	*Tristania merguenensis* Griff.

Based on the report of the biodiversity in the Giam Siak Nature Reserve, there were about 125 species of 34 family (Anonim, 2007). This observation was found about 20% of the total species. Therefore, this area still requires further exploration.

(4) Important value index

The important value (IV) analysis result indicates that the most important species in the transect area is Cryptocarya cf. Teysmanniana Miq.(IV = 63.46) and the species with the lowest IV value is Tristania merguenensis Griff. (IV = 0.65). Table 5 showed the species with the IV over 10.

Table 10 Important Value for Spesies in Research Plot

No.	Scientific Name	Basal Area (m^2)	IV
1	*Cryptocarya cf. Teysmanniana* Miq.	2,39	63,46
2	*Ganua motleyana (de Vriese)* Pirre ex Dub.	1,04	30,83
3	*Shorea* sp.	1,29	25,10
4	*Dialium indum* L.	1,50	22,51
5	*Syzygium clavatum (Kort.)* Merr. & Perry	0,29	14,44
6	*Acronychia pedunculata* (L.) Miq.	0,38	11,71
7	*Symplocos conchichinensis* (Lour.) Moore	0,37	11,04

To know the diversity index we calculated by using species diversity index (Shannon-Winner Index), with the value obtained was 2.1. Diversity index calculation is shown in the Table 11. The results showed that the diversity index was lower than the index in the logged forest areas. Diversity index in the peat swamp forests ranged from 2.96 to 3.68, in the five years logged forest and the

primary forest area, respectively (Heriyanto and Subiandono, 2007).

Table 11 Result of Diversity Index (Shannon-Wienner Index)

No.	Scientific Name	H’
1	*Cryptocarya cf. Teysmanniana Miq.*	0,36
2	*Ganua motleyana (de Vriese) Pirre ex Dub.*	0,25
3	*Shorea sp.*	0,17
4	*Dialium indum L.*	0,14
5	*Syzygium clavatum (Kort.) Merr. & Perry*	0,15
6	*Acronychia pedunculata(L.) Miq.*	0,12
7	*Symplocos conchichinensis (Lour.) Moore*	0,12
8	*Hopea sp.*	0,09
9	*Baccaurea javanica (Blume) Mull. Arg*	0,04
10	*Durio zibethinus Murr.*	0,04
11	*Knema furfuraceae (Hk.f. Et Th.) Warb.*	0,04
12	*Cryptocarya infectoria (Bl.) Miq.*	0,04
13	*Timonius wallichianus Val.*	0,04
14	*Diospyros diepenhorstii Miq.*	0,02
15	*Mangifera cf. Foetida Lour.*	0,04
16	*Licuala spinosa Thunb.*	0,02
17	*Plectronia cf. Conferta Val.*	0,02
18	*Barringtonia scortechnii King.*	0,01
19	*Gomphia serrata (Gaertn. Kams.*	0,01
20	*Dissochaeta bracteata (Jack.) Blume*	0,01
21	*Syzygium acuminatissima Merr. & Perry*	0,01
22	*Tristania merguenensis Griff.*	0,01
	Total	2,10

3.1.2.8 Drivers of ecosystem service changes

Indirect drivers impact to the ecosystem services could be discribed as follow: Population change (demographic drivers), Change in economic activity,

Indirect driver In Temiang village were: planting rice, rubber, and palm tree, breeding chicken, cows and pigs. Other jobs are self-employed, Government employees and private business.

In Tasik Betung were: Sociopolitical drivers (in Riau, Dutch East Indies government gives orders to build a rubber plantation. In 1864, rubber was introduced and developed in Indonesia.

Direct driver in Temiang were: land use change patterns of other uses (forest, shrub, open land and fields) into a rubber plantation, fields and road construction

We analysed indirect and direct factors which were impact to the ecosystem services. The scheme was developed as follow:

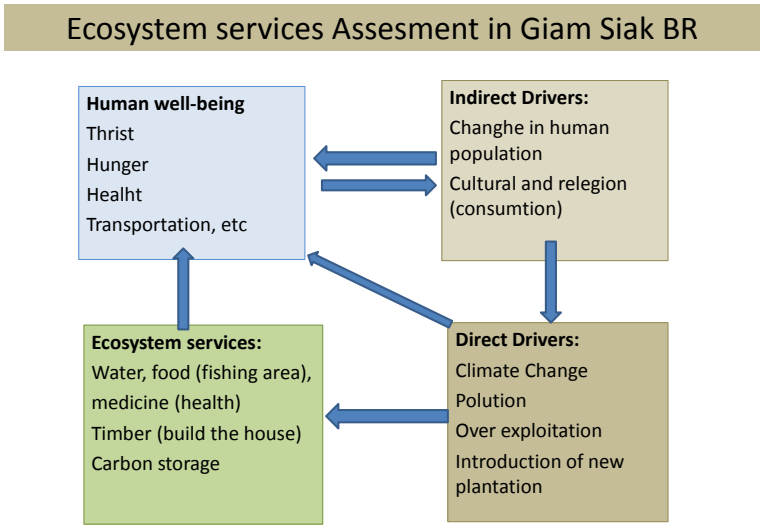


Figure 25 The Ecosystem services assesment in the villages around Giam Siak Biosphere Reserve.

The figure above described the impact of the land use change through direct and indirect factor to the ecosystem services, and subsequently will affect to the human wellbeing.

The strategy of communication should be developed to Achieve the ecosystem services mechanism, which include the stake holder (local government, private company) and the villager. During the assesment process, stake holder should be involved in all stage of assesment and the report during this process should be submit to the stake holder with very simple ways.

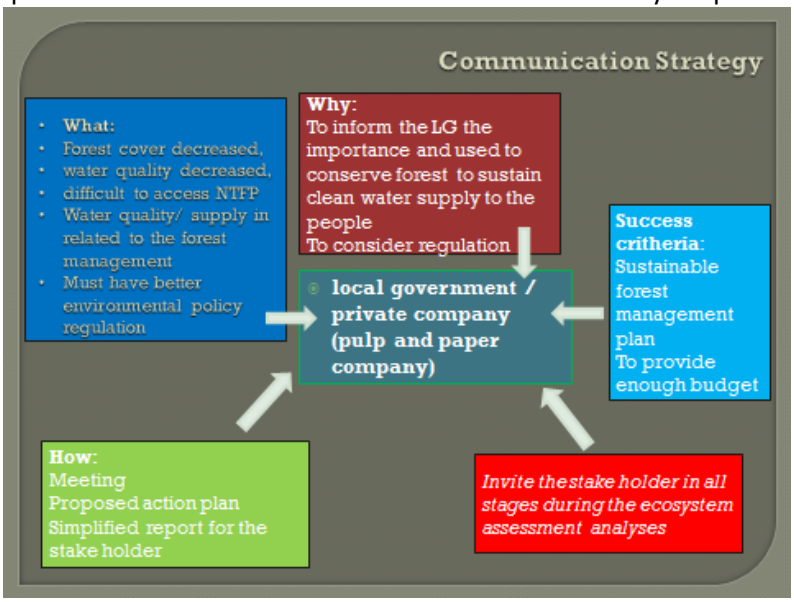


Figure 26 The strategy communication of ecosystem services assessment.

3.1.2 Tanguor haor in Bangladesh

3.1.2.1. Changes of land use and other resources over time

(1) Changes in land use pattern

The Tanguor haor had have diversified land used and land cover (LULC) from a long time. The major land use pattern was water bodies (beel and river) (46.2%) followed by single and double cropland (20.5%) in 1989. The other important LULC were mudflat, settlement and swamp forest (Figure 27 & Table 12). The analysis of satellite images showed that over time (during 1989-2010),

water bodies decreased 14.4% of the total studied area, but area under other land uses increased except some area under double cropped that decreased probably due to seasonal variation in land use. The area under water bodies have been transformed to mudflat as well as single cropland. During the study period swamp forest also increased 1.1% of based on total area. These findings justified with the perception of local community. The findings also illustrated that the shrinking of water bodies will be continued and predicted 18.9% of the total area in 2020, and will be transform into new mudflat and single cropland. The steady increase of mudflow was the evidences of decrease of water bodies.

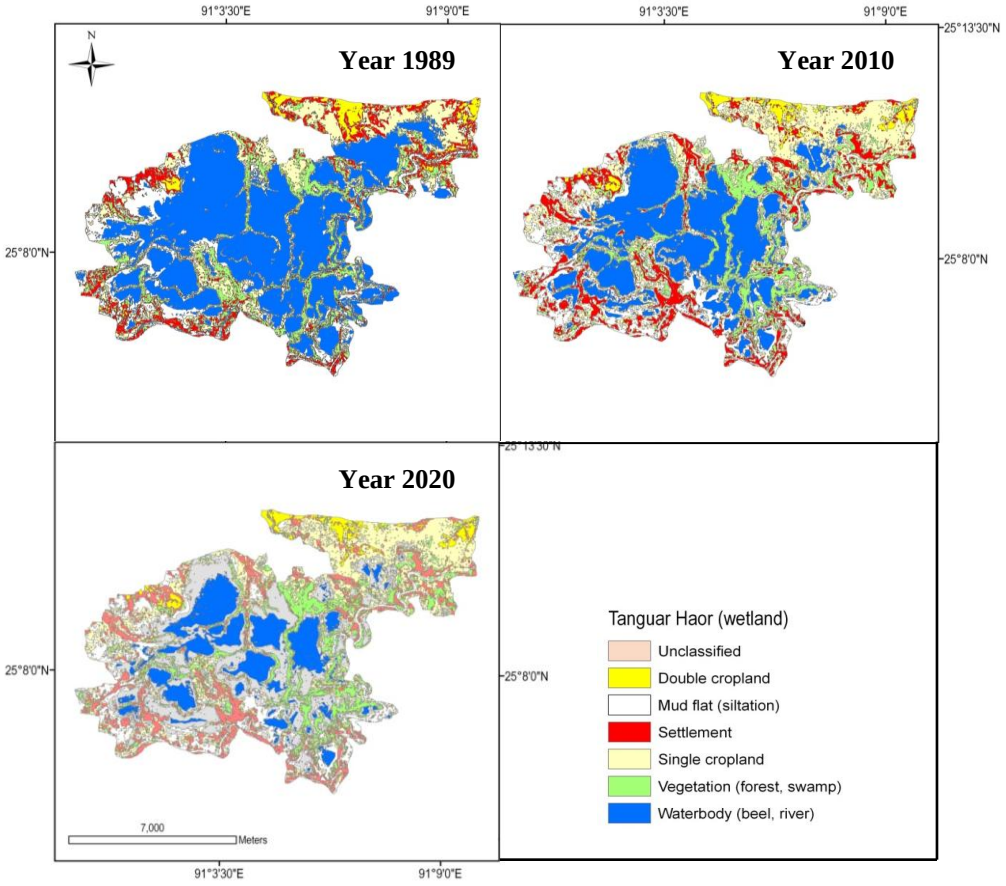


Figure 27 Land use land cover map in the study area.

Table 12 Land use change during 1989-2010 and prediction of siltation in 2020 in Tanguar haor

Land use and land cover types (LULC)	1989		2010		2020*		Area Change 1989-2010	% Area Change 1989-2010
	Area (ha)	%	Area (ha)	%	Area (ha)	%		
Settlement	1157	10.2	1454	12.8	1454	12.8	297	2.6
Double cropland	328	2.9	314	2.8	314	2.8	-14	-0.1
Single cropland	2003	17.6	2889	25.4	2753	24.2	886	7.8
Vegetation (swamp forest)	1084	9.5	1209	10.6	1209	10.6	125	1.1
Mudflat (siltation)	1561	13.7	2168	19.0	1863	16.4	606	5.3
Water bodies (beel, river)	5261	46.2	3359	29.5	1646	14.4	-1902	-16.7
Mudflat (predicted siltation)	-	-	-	-	2154	18.9	-	-

*only area under siltation has been predicted

(2) Changes of other resources

(2.1) Changes of rice varieties over time

The major farming in the haor area is the boro rice (winter season) cultivation because of long-term land inundation during the rainy season. About 0.68 million ha area (80%) is occupied by boro rice, while others are under transplanted aman (Huda, 2004). High yielding boro rice cultivation is generally restricted due to early flood, hailstorm and drought. The study showed that over 10 years' time, due to development of suitable rice variety, cultivation of HYV rice significantly increased replacing local rice varieties in the area. The most remarkable adoption of HYV rice varieties includes BR28 and BR29. For the last 10 years, these two rice varieties have become almost double (Table 13) In contrast, except two fine rice cultivars i.e. Shail and Gochi all the local cultivars decreased to a great extent. The decreasing trend varied from 28.38 to 68.33%.

Table 13 Respondent's opinion on changes of rice varieties over time in the study area

Rice variety	Respondent's opinion on changes of rice varieties over time (%)		Change (%)
	10 years before	Year 2010	
	High Yielding Rice (HYV)		
BR28	17.60	34.80	+97.73
BR29	12.75	24.45	+91.76
BR19	18.40	21.20	+15.22
BR45	7.40	9.80	+32.4
Hira	8.20	6.20	-24.40
	Local Rice (LR)		
Shail	10.60	11.16	+5.28
Gochi	13.85	14.45	+4.33
Tepi	8.48	5.78	-31.84
Baygun Bachi	9.55	6.84	-28.38
Agni	9.90	6.48	-34.55
Agam	9.14	4.46	-51.80
Lakai	8.13	3.71	-54.37
Rata	7.42	3.14	-50.00
Basful	7.42	2.35	-68.33

(2.2) Changes in homestead forest/tree species

Changes in dominance of tree species over time in the homestead area are expressed as relative prevalence (RP) (Table 14). About 21 woody and fruit species have been identified in the study area. This indicated a very good tree biodiversity in the homestead area. Based on RP values, the dominant woody species were Koroch (Pongamia pinnata), Hijal (Barringtonia acutangula), Raintree (Samanea saman) and Mehogony (Swietenia macrophylla) and that of fruit species Mango (Mangifera indica), Jackfruit (Artocarpus heterophyllus), Guava (Psidium guajava), Blackberry (Syzygium cumini) and Betel nut (Areca catechu) in the study area. In 2012, the RP of Koroch (Pongamia pinnata), Hijal (Barringtonia acutangula) and Acacia (Acacia auriculiformis) increased and others are decreased. All the fruit species showed decreased RP in 2012 indicating gradual extinction of all fruit species in the study area. The increase of RP for Koroch (Pongamia pinnata), Hijal (Barringtonia acutangula) were 80.6 and 42.89% respectively during 2000-2012. This indicated their ability to withstand standing water for a long time possibly because of their genetic makeup and adaption to the site. There were very low RP values in some species like Bilimbi (Averrhoa bilimbi) Neem (Azadirachta indica), Sofeda (Manilkara achras), Olive (Olea europa), Coconut (Cocos nucifera) indicated they were about to extinct. The Shannon-Wiener Diversity Index (H) that indicates the species abundance and richness showed that diversity of tree species decreased from 2.60 in 2012

to 1.96 in 2000 in the study area (Figure 28). This indicated that the species abundance and richness became poor and needs restoration measures.

Table 14 Changing scenario on the relative prevalence of tree species in homestead area during 2000-2010

Name of tree species	Relative prevalence of tree species over time		% Change
	2000	2012	
Forest/woody species			
Acacia (*Acacia auriculiformis*)	0.50	0.60	+20.00
Hijal (*Barringtonia acutangula*)	4.36	6.23	+42.89
Khair (*Acacia catechu*)	0.32	0.28	-12.50
Koroch (*Pongamia pinnata*)	5.27	9.52	+80.65
Koroi (*Albizia* sp)	0.95	0.44	-53.68
Mehogony (*Swietenia macrophylla*)	1.29	0.36	-72.09
Neem (*Azadirachta indica*)	0.83	0.04	-95.18
Raintree (*Samanea saman*)	1.98	1.44	-27.27
Shimul (*Bombax ceiba*)	0.78	0.28	-64.10
Fruit species			
Betel nut (*Areca catechu*)	1.28	0.48	-62.50
Bilimbi (*Averrhoa bilimbi*)	0.92	0.04	-95.65
Blackberry (*Syzygium cumini*)	0.87	0.72	-17.24
Coconut (*Cocos nucifera*)	1.02	0.16	-84.31
Custard apple (*Annona squamosa*)	0.36	0.3	-16.67
Guava (*Psidium guajava*)	1.01	0.72	-28.71
Jackfruit (*Artocarpus heterophyllus*)	1.46	0.76	-47.95
Jujube (*Zizyphus jujube*)	1.11	0.24	-78.38
Lemon (*Citrus limon*)	0.58	0.36	-37.93
Mango (*Mangifera indica)*	3.56	2.28	-35.96
Olive (*Olea europa*)	1.45	0.16	-88.97
Sofeda (*Manilkara achras)*	0.46	0.04	-91.30

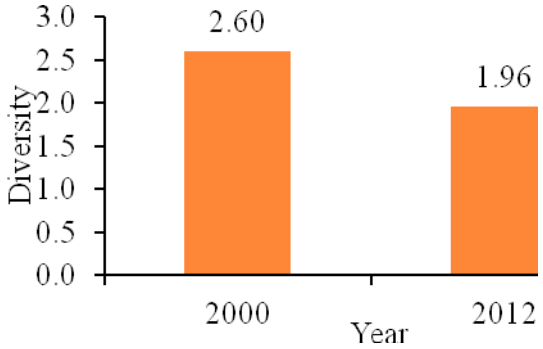


Figure 28 Diversity Index of tree species in the study area. Index note: 0-2 = poor and need restoration measure; 2-3 = abundant and need protection work; and >3 = rich and naturally survived.

(2.3) Changes in swamp forest

Swamp forests are inundated with freshwater either permanently or seasonally. It is normally occurred along the lower reaches of rivers and around freshwater lakes. The forest goes under 7-10 meters water during rainy season. Rest of the year, the water level is about 3 meters deep. This forest is the good shelters of the fishes during rainy season. It is the habitat of different snakes,

monkeys, lizards, insects and birds. The changes of swamp forest both in area and species richness over time in Tanguar haor are illustrated in Table 15. The major swamp forests species recorded in the different locations are Pongamia pinnata, Barringtonia acutangula, Crataeva nurvala, Sonneratia caseolaris, Erythrina variegata, Phragmites karka, Saccharum spontaneum, Ipomoea alba, Trewia polycarpa, Girardinia heterophylla, Typha elephantine, Hibiscus tiliaceus. It is interestingly observed that the swamp forest increased in 7 locations while it increased in 7 locations also. The increase of swamp forest in several locations was because of various promotion activities primarily the social forestry program implemented by the government and non-government organizations which reflect the development of plant biodiversity. The decreasing trend in several places was possibly because of harvesting of swamp forest and unsuitable for new plantation.

Table 15 Change of swamp forest both in area and species richness over time in Tanguar *haor*

Location of observation	Area (ha)		% Change	Species richness		% Change
	Year 2000	Year 2012		Year 2000	Year 2012	
Alamdaor	12.36	8.77	-41.04	4.66	1.2	-74.25
Bagmara Kanda	8.24	6.48	-27.31	3.13	2.88	-7.99
Binnabon	8.15	6.27	-30.00	5.00	4.83	-3.40
Kailary Kanda	8.34	5.16	-61.73	2.00	1.25	-37.50
Kaillatur	6.62	9.93	+50.00	1.86	2.90	+55.91
Nainder Haor	7.76	11.13	+43.45	1.17	2.00	+71.38
Osakanda	7.62	11.52	+51.06	2.80	5.00	+78.57
Patichula	8.22	10.87	+32.30	3.21	3.87	+20.56
Poilla Beel	13.41	17.20	+28.28	3.00	3.50	+16.67
PuranGaon	13.15	9.78	-34.46	3.00	2.00	-33.33
Rajar Dai	6.27	4.86	-29.17	2.67	1.91	-28.46
Razdaigang	11.38	14.42	+26.66	1.75	3.00	+71.43
Ulush Nagar Kanda	5.75	9.89	+71.87	2.13	2.53	+18.78
Mean	9.02	9.71	+7.65	2.80	2.84	+1.43

(2.4) Changes in fish resources

Fish resources in Tanguar haor declined remarkably during the last decade. In 2000, this wetland ecosystem was the home of 128 varieties of fish which is about half of the freshwater fish varieties in Bangladesh, but recently many of them have been found to extinct. Fish species in the study site was categorized into seven groups according to abundance or availability (Table 16). The high availability of fish species expressed as very common, common and fairly common groups decreased remarkably showing 42.86, 20.00 and 11 54%, reduction, respectively. While less abundance or threatened species in terms of few, very few, occasional and very rare groups were increased manifolds. Therefore it is urgent need of undertaking conservation measures for sustainability of very common fish species. Respondent opinion on the availability of fish resources when compared for present status to 10 years before showed a strongly support of changing fish species over time. More than 50% respondents opined that Darkina (Rasbora rasbora), Moha shol (Tor Tor), Chitol (Chitala chitala), Boro boal (Wallago attu), Boro Rui (Labeo rohita), Kali Baush (Labeo calbasu), Ayer (Sperata aor), Katla (Catla catla), Mrigel (Cirrhinus cirrhosus), Chanda (Chanda nama), Meni (Labeo ariza), Baim (Mastacembelus armatus), Koi (Anabas testudineus) were the abundant fish species in Tanguor haor in 10 years before, but those abundant species were reached to either less abundant or endangered stages.

Table 16 Changes of fish species over time in the study area

Species availability	Changes of fish species (type of species)		
	Year 2000	Year 2010	Change (%)
Very common	28	16	-42.86
Common	35	28	-20.00
Fairly common	26	23	-11.54
Few	15	22	+46.67
Very few	19	23	+21.05
Occasional	4	9	+125.00
Very rare	1	3	+200.00

Note: very common=very high abundance, common=high abundance, fairly common=moderately abundance etc.

(2.5) Changes in bird resources

About 30 migratory and residential bird species was recorded from five beels of Tanguar haor of which 11 species were presented in Table 6 based on number of birds available in the area. Alam and Hasibur (2011) recorded a total 167 species (65010 in number), among them 83 species are resident and the rest 84 are migratory. In this study the common and most prevalent bird species were Gadwall (1905), Eurasian Coot (930), Purple Swamphen (810), Tufted Duck (320), Eurasian Wigeon (305) and Pheasant-tailed Jacana (300) in 2000. The number of birds of all species decreased in varying degree ranging from 21.3-75.0%. Among them, Grey headed Lapwing, Tufted Duck and Eurasian Coot showed more than 50% reduction. The decreasing trend of bird species was strongly supported by the respondents opinions recorded during PRA, household survey and FGD. The reasons for decreasing trend of the number of birds regardless of species were the increasing trend of hunting and other anthropogenic activities particularly, habitat destruction, persecution in cage and perhaps accidental poisoning (CNRS, 2007). The Shannon-Wiener diversity index (H) showed that the diversity index of bird species decreased from 2.13 to 1.98 over the last 10 years (Figure 29).

Table 17 Changing scenario of different bird species in the study area over time (in surrounding 5 *beels* out of 120 *beels*)

Name of birds	Number of birds		% Change
	Year 2000	Year 2010	
Gadwall	1905	1500	-21.3
Eurasian Coot	930	411	-55.8
Purple Swamphen	810	530	-34.6
Tufted Duck	320	111	-65.3
Eurasian Wigeon	305	210	-31.2
Pheasant-tailed Jacana	300	140	-53.3
Little Cormorant	225	120	-46.7
Gergeny	220	125	-43.2
Common Moorehen	100	53	-47.0
Cotton Pygmy-goose	52	34	-34.6
Grey headed Lapwing	40	10	-75.0

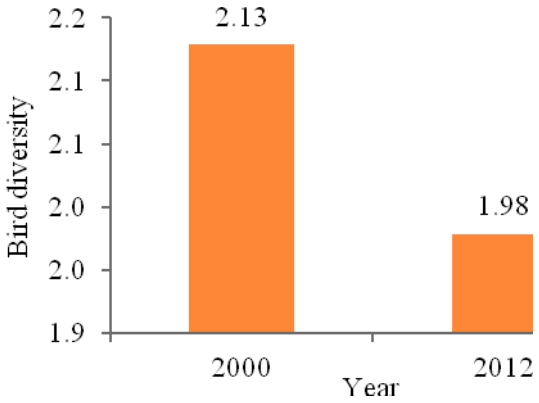


Figure 29 Diversity Index of bird species over time in the study area. Index note: 0-2 = poor and need restoration measure; 2-3 = abundant and need protection work; and >3 = rich and naturally survived.

3.1.2.2. Driving forces of land use changes and depletion of other resources

(1) Natural factors/forces

The major natural driving forces influencing on the land use changes and depletion of other resources are sedimentation/siltation and climate change.

(1.1) Sedimentation /siltation:

This is a natural process. This wetland act as sinks of huge monsoon rain water that comes from upstream especially from Meghalayan hills of India and Khasi hill of Bangladesh, and as a result it looks like a sea in monsoon. The rainwater flows to the wetland brings huge sediments every year and deposits to this wetland and as a results bottom beds of this wetland are raising up. In addition, sediments also come from soil erosions due to various disasters such as flash flood, early flood and river and wave erosions. Because of continuous deposition of sediments and lack of dredging of rivers and beels, many areas are raised up already and converted to rice growing areas and other purposes. On the other hand area uses for fish production and birds' shelters are decreasing. The analysis of satellite images and opinions of respondents and experts strongly supported these statements.

(1.2) Climate change:

Climate change is also acts a driving force for land use changes though its role is not so prominent.

Temperature during 1961-2010 showed a steady increasing trend of both maximum and minimum temperatures over time (Figure 30 and 31). The increment rate of maximum and minimum temperatures were 0.025 and 0.019°C per year, respectively, indicating that increase in maximum temperature was more pronounced than that of minimum temperature. It was observed that the minimum temperature during winter season (December-January) had been slightly decreasing, while it exhibited increasing trend in rest of the months. This indicated a gradually warming of the area regardless of seasons. High temperature may decrease the oxygen concentration of water. These changes might have impact on the suitable host for the migratory birds and resident birds as well incidence of pests and diseases as well as productivity of the fishes, crops and forest vegetation.

The long-term changes in rainfall were not significant over seasons. The annual drought and wet frequency corresponding to standardized precipitation index (SPI) in the study area has been shown in Figure 6. The result revealed that drought frequency was dominant in the recent years and the SPI values crossed the normal level (-0.5 to +0.5) in most of the years. The results also showed that rainfall distribution fluctuated sharply that indicate heavy rain in sometime and no rainfall in other times. Subash and Mohan (2011) reported a wide year-to-year variability in the monthly distribution

of rainfall in Indo-Gangetic region. These might have caused flash flood accompanied with high rate of soil erosion and sedimentation. On the other hand, drying up the canals and rivers in drought year. These might have also impacts on maintaining crop calendar and productivity of fishes.

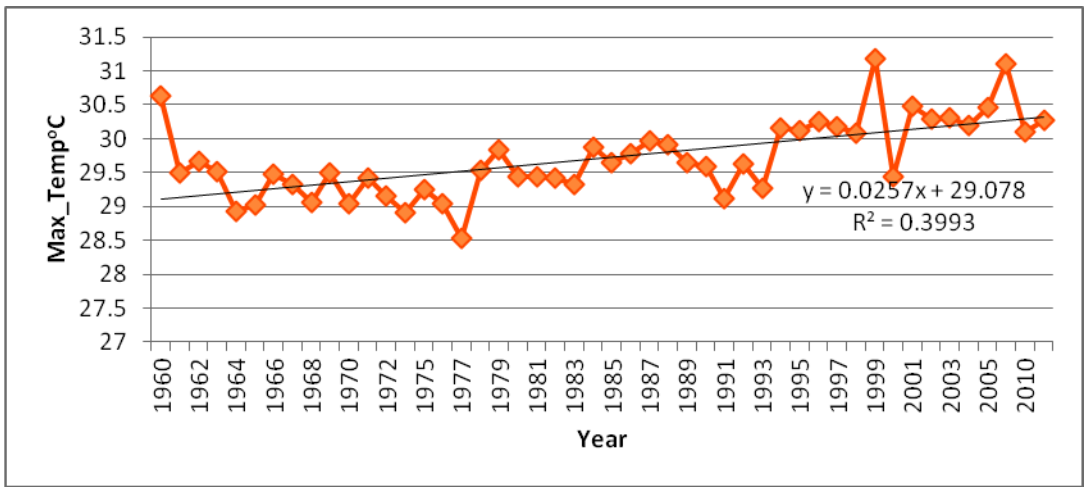


Figure 30 Long-term (1961-2010) trend of maximum temperature in the study area.

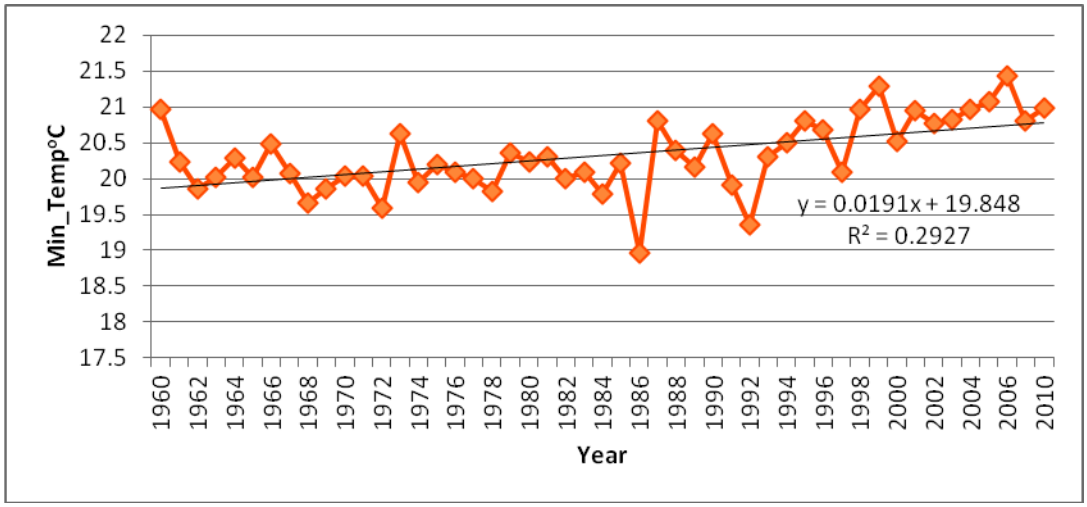


Figure 31 Long-term (1961-2010) trend of minimum temperature in the study area.

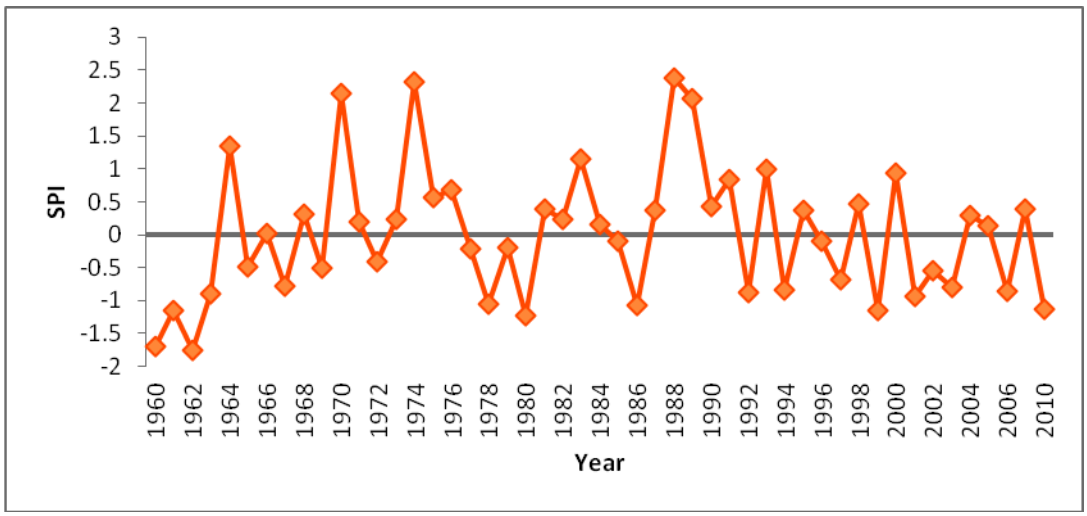


Figure 32 Long-term (1960-2009) annual Standardized Precipitation Index (SPI) in the study area indicating frequency of dry and wet conditions.

(2) Anthropogenic factors/forces for land use change

The important anthropogenic factors were identified through PRA, respondents' survey and consultation with local experienced peoples. The opinions of respondents and others have been summarized in Table 18. The findings showed that a number of factors/driving forces have been influencing on the land use change, depletion of other resources as well as on livelihood opportunities of the local community. Some driving forces were found as severe and some were moderate. The most acute factor was over exploitation of resources (opined by 90% of the respondents). The second topmost important factor was the siltation and sedimentation due to flash flood, land erosion, sand and stone mining (86%), and the third one was increased agricultural activities and over use of agro-chemicals (76%). The fourth force was loss of habitat/food/shelter for birds, fishes and other aquatic animals. The fifth ranking force was over use of water pollution from agrochemicals, oil spills of boat transportation (66%) resulting scarcity of water for irrigation and drinking purposes. Increase population growth and new settlement (60%) were the sixth factor. The next factor was lack of dredging and poor management of resources. The others driving forces i.e., forest concession (40%) and Urbanization (30%).

Table 18 Driving forces of land use change and depletion of other resources in Tanguar haor.

Driving forces of Tanguar Haor wetland	Respondents' opinion		Rank
	Frequency	Percent	
Over exploitation of resources (fishing, hunting birds, collection of reed, aquatic weed etc)	54	90	1
Siltation and sedimentation due to flash flood, land erosion, sand and stone mining	52	86	2
Increase agricultural activities and overuse of agro-chemicals	46	76	3
Loss of habitat/food/shelter for birds, fishes and aquatic animals	43	72	4
Water pollution from agrochemicals, oil spills of boat transportation	40	66	5
Increase population growth and new settlements	36	60	6
Lack of dredging and poor management resources	35	58	7
Forest concession	24	40	9
Urbanization	18	30	10

3.1.2.3. Changes of major ecosystem services in past 10 years

Once the Tanguar haor wetland provided all the major household requirements and other services to the community but these have been remarkably decreased during the last 10 years (Table 19). In 2000, most of all basic needs of the community like fish and food were fulfilled from haor resources, but now their supplies reduced up to 80 and 60%. Out of 80% fuel wood/cooking materials those generally came from reeds, leaves and branches of swamp forest have been reduced to 56.3% from 2000 to 2010. Once the haor was considered as the best safe home of local and migratory birds, but now these safe places have been reduced to 64.3%. About half of the drinking water requirement was met up from haor's water bodies in 2000. Now this source of drinking water reduced 50% because of impurity caused by various anthropogenic activities. However, haor has been using as a major source of irrigation water, although water has been polluted heavily. Conversely, increasing siltation in lakes/beels assumed 30.7% during 2000-2010 which causes frequent overflow of water and flood during rainy season. Use of swamp forest as a source of raw materials for house making reduced drastically for the last 10 years possibly because of alternative raw materials like galvanized steel/metals are available which is affordable for improving economic conditions of the people. In spite of enormous opportunities of the site for recreation and development of tourism, various facilities including communication have not yet developed in the area.

Table 19 Impact of changes of land use and resources of Tanguar *haor* on ecosystem services over time based

Ecosystem service	Changes of ecosystem services		Change (%)
	Year 2000	Year 2010	
Fish	100	80	-20.0
Food	100	60	-40.0
Fuel wood/cooking material	80	35	-56.3
Fiber	45	33	-26.7
Bird's habitat	70	25	-64.3
Source of drinking water	50	25	-50.0
Source of irrigation water	100	100	0.0
Siltation/sedimentation and rising up of land	62	81	+30.7
Natural hazards control/regulation (mainly flood)	40	20	-50.0
Source of house making materials	100	15	-85.0

3.2 Scenarios assessment

3.2.1 Identification of scenarios of land use change

3.2.1.1 Research method

(1) Detailed data collection methods

(1.1) First hand data collection method

In order to tradeoff different land use policy, FoPIA (Framework of Participatory Impact Assessment) is used to set land use policy scenarios, and assess the biodiversity and soil retention change trends. 11 experts with special background from different governmental agencies were invited. They are asked to set 3 future development scenarios. Experts had also set four indicator which impact on biodiversity and soil retention. And then they score the index change trends under different scenarios, using numbers in [-3, +3] to show the trends, if the score is positive number, it represent an increase trends, otherwise a decrease trends. Indicator weight for its corresponding ecosystem services are also scored by experts, value number is in [0, 10].

The computational formula for the total value of each scenario is:

$$Wi_d = \sum_{j=1}^{n} W_{f.d} * i_{f.d}$$

Wi represent the final value of the ecosystem services under future scenarios, $W_{f.d}$ is Indicator's weight impact on ecosystem services. $i_{f.d}$ represent the average value of the indicator in different scenarios. d represent different scenarios, f represent different indicator.

Moreover, we take 1 typical village in Poyang Lake wetlands to simulate change of migratory bird under different scenarios by InVEST model. The future habitat map, Land use/cover map was shaped by different FoPIA discussion.

(1.2) Second hand data collection method

InVEST parameter was collect from score by expert, literature study and InVEST data base. More details please check the output 2: Package of assessment methods and techniques.

(2) Detailed data analysis methods

FoPIA result was analysis by mathematical statistics. Some FoFIA result such as variation trend of land use/cover indicator was used in InVEST model.

3.2.1.2 Research findings

(1) Scenarios of land use change identified for Poyang Lake wetlands

Discussion from FoPIA had defined the scenarios of the future, that is: conservation scenarios, economic development scenarios and baseline scenarios. The driving force of the scenarios (scenarios parameters) is considered as ecological project, agriculture input and farmers' income level.

(2) Description of each scenario

(2.1)Scenario setting

Definition of three scenarios(table 20): (1)Conservation scenario: On contract of the current reality, the scale of the implement of the return farmland to lake project (primarily increasing the wetland scale) will increase 30% till 2020 while returning the slop cultivated land which is inconvenient to cultivate and has poor quality or on the slop land over 15 degree except that basic agricultural input levels remain the same and per capita net income of farmers increases by 10.8%; (2) Economic scenario: under the impact of market and government measures, farmers realize the economic benefits of land use which leading to the basic agricultural input and per capita net income of farmers increasing at the rate of 15% and 25%; (3) Baseline scenario: the basic agricultural input levels and per capita net income of farmers increases at the rate of 4.4% and 10.8%.

Table 20 Land use scenario and parameters

Scenario / Parameters	Conservation	Economic development	Baseline
Return farmland to lake	Increase by 30% in 2020	stop	stop
Returning farmland to forest	Returning cultivated land (slope above 15) to forest	stop	stop
Agriculture input	Maintain the current level	Average annual growth rate by 15%	Average annual growth rate by 4.4%
Net income of farmers	Average annual growth rate by 10.8%	Average annual growth rate by 25%	Average annual growth rate by10.8%

(2.2) Scenarios assessment:

According to scenario computational formula, the biodiversity value under conservation scenario, economic development scenario, baseline scenario are 20.93, -22.52 and 0.87 respectively. It will be

in high biodiversity level under conservation scenario (table 21).

Table 21 land use/cover indicator weight which impact on biodiversity and the final scenario value

scenarios	Forest		Nature wetlands		Construction land		Agriculture land		scenario value
	weight	Value i	weight	Value i	weight	Value i	weight	Value i	
Conservation		2.16		0.73		0.08		-0.06	20.93
Economic development	7.5	-0.05	6.5	-1.38	3.8	-0.84	5.3	-1.89	-22.52
Baseline		0.07		0.32		-0.96		0.36	0.87

According to scenario computational formula, the biodiversity value under conservation scenario, economic development scenario, baseline scenario are 19.67, -3.18 and 0.21 respectively. It will be in high soil retention level under conservation scenario (table 22).

Table 22 Indicator weight affecting soil retention and the final scenario value

scenarios	Forest		Soil organic matter		Slope cropland		Multiple crop index		scenario value
	weight	Value i	weight	Value i	weight	Value i	weight	Value i	
Conservation		2.2		-0.33		1.2		0.1	19.67
Economic development	6.46	-0.4	4.92	-0.76	5.68	0	2.62	1.2	-3.18
Baseline		0.2		-0.54		0.6		-0.7	0.21

3.2.2 Scenario and land use analysis of change impact on ecosystem services

3.2.2.1 Simulation method

(1) Introduction of InVEST model

The InVEST ecosystem services analysis model was developed by Stanford University in collaboration with other institutions in 2010, and it has since been widely used. InVEST consists of a suite of models that use LU/LC patterns to assess values of ecosystem services and biodiversity conservation. Examples of ecosystem services and commodity production that InVEST can model include water quality, water provision for irrigation and hydropower, storm peak mitigation, soil conservation, carbon sequestration, pollination, cultural and spiritual values, recreation and tourism, timber and non-timber forest products, agricultural products, and residential property values.

(2) Detailed data collection methods

By FoPIA discussion, we get 4 land use/cover index which impact on biodiversity of Poyang Lake

wetland. The 4 index are forest land, wetland, construction land and agriculture land. From FoPIA discussion, we also get the tendency of the 4 index under different scenarios, using percentage number to represent the tendency. The future habitat map, Land use/cover map can be shaped by land use/cover change tendency.

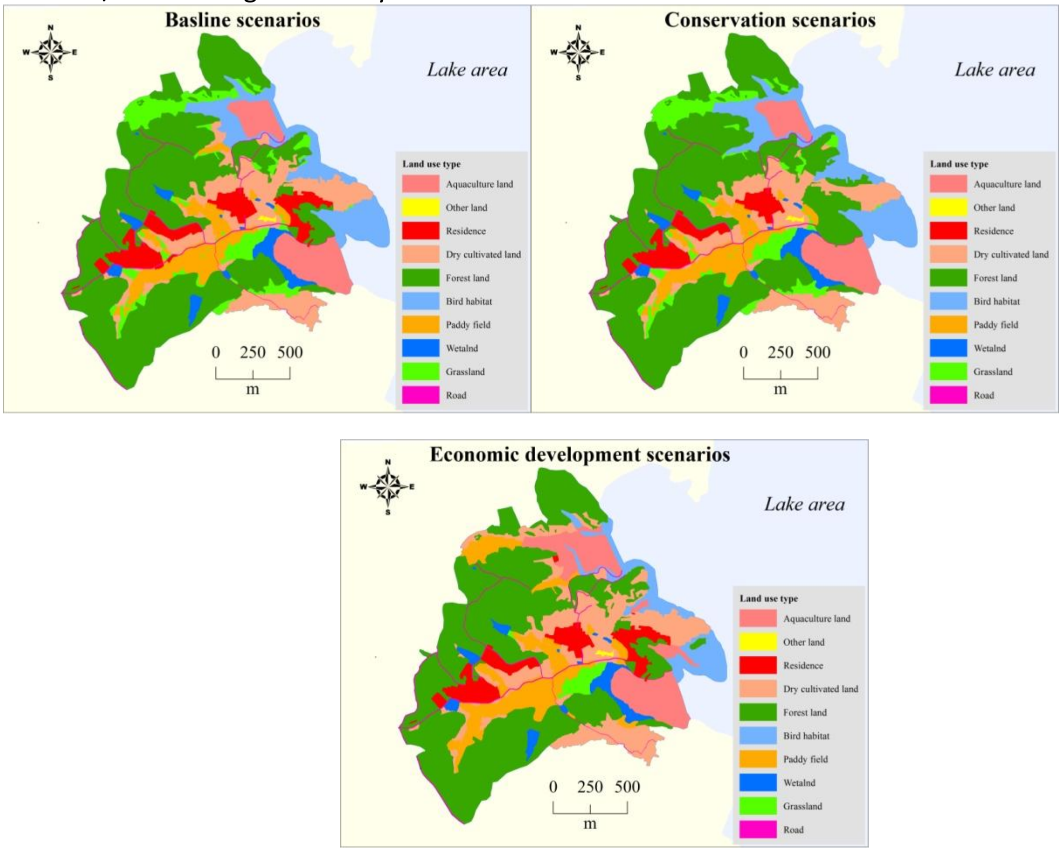


Figure 33 Land use/cover map under different scenario

(3) Detailed data analysis methods

The model considers four parameters: a). Habitat type: Different habitats have different suitabilities for migratory birds; for example, swampland is more suitable than paddy fields for most migratory birds. b). Intensity of threat: Birds are affected differently by different threats. For example, most human settlements are more stressful than vehicle traffic, and the effect of road traffic varies among traffic levels. c). The distance between the habitat and the stressor, and the associated stress pathways (both linear and nonlinear): The effect will decrease with increasing distance, but the decrease may be linear or nonlinear. Because the default for InVEST is a linear rate of change, we chose that option. In future research, it may be worthwhile testing whether a nonlinear trend would be appropriate for some situations. d). Habitat sensitivity: Each habitat varies in its sensitivity to different types of stressor.

The four parameters data can be got from score by expert, literature study and InVEST data base. By input those four parameters, and some spatial data (Land use/cover data, habitat distribution data), and we can get the habitat quality map under different scenario.

3.2.2.2 Findings of ecosystem service changes affected by land use change

(1) Simulation results of impact of land use change on ecosystem services in Poyang Lake wetland

Results as followed: Under the conservation scenario, the average quality of the habitat of Migratory birds was 0.89, 36.9% higher than the current level which was 0.57, 12.3% lower than the current level under the economic scenario, and was 0.66, 1.5% higher than the current level under

the baseline scenario.

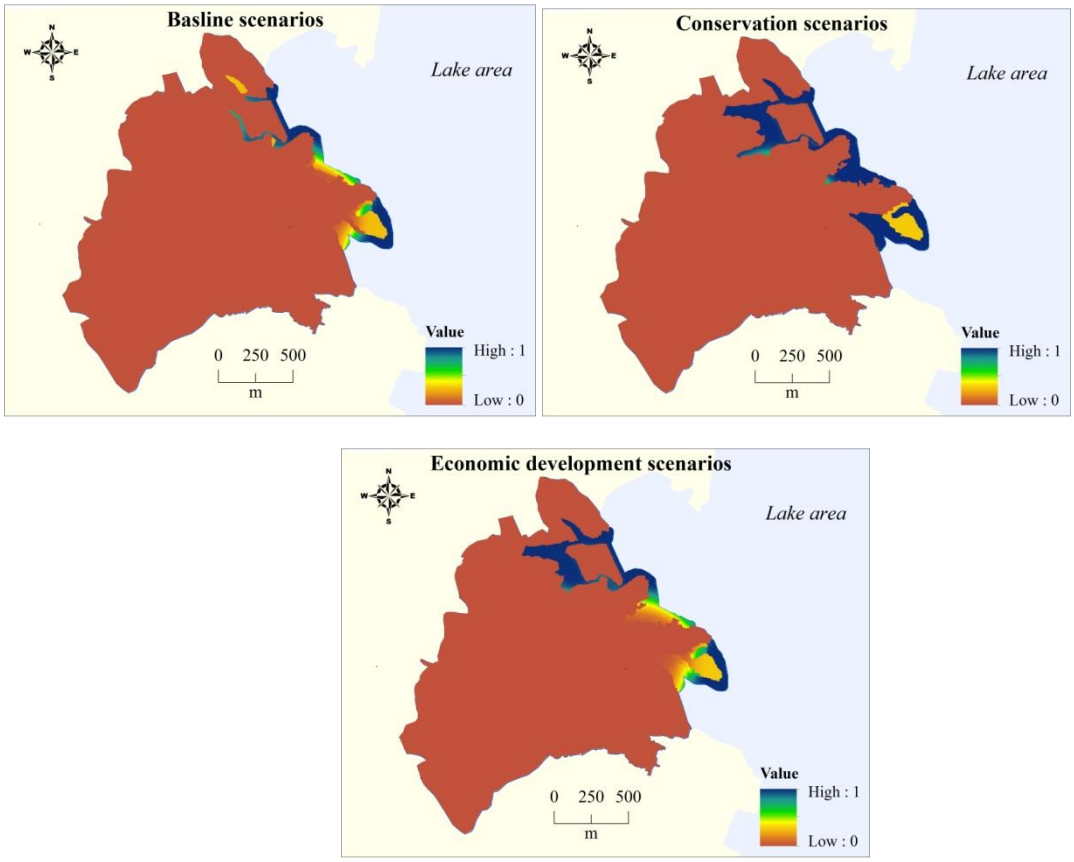


Figure 34 Simulation results of habitat quality of the typical village

(2) Explanations and discussions of the findings

Under scenarios of conservation, the effect of RFL and RFF policy will be continue, and the agriculture input will be maintain by the current status level. Habitat quality of the migratory bird will be 0.80, increasing by 36.9% comparing to current status. Moreover, the nature wetlands which is suitable to migratory bird increased by 24.3%; Under scenarios of economic development, the average quality of the habitat of migratory bird is 0.57, decreasing by 12.3% comparing to current status. In this scenarios, ecological project will be stop, and the agriculture input will be increasing, making agriculture land increase by large amount (by 63.0%). Moreover, the new building house will be increase by 28.0% because of economic development making rural income increase in large amount. The result of agriculture land and residence land increasing make human activities stress on habitat much more intensify. In addition, 46.0% of the current wetland was occupied by aquafarm; Under scenarios of baseline, the average quality of the habitat of migratory bird is 0.66, increasing by 1.5% comparing to current status, there are no ecological project in that scenarios, and cultivated land abandoned phenomenon increasing because of agriculture comparative benefit are very low, but this phenomenon would make human activities stress on habitat become less, and paddy field abandoned cause some nature wetland increasing to some extent (by 4.0%). But then migrant workers go to cities increasing. According to expert introduction, in Poyang Lake wetlands, it is common phenomenon to building house after migrant workers come back from the city. so construction land will be increasing by large amount (32.0%) in that scenarios, which intensify human activities effect on migratory bird habitat. Overall, habitat quality will not increasing obviously.

3.2.3. Synthesis of research findings and development of decision support tool

The decision support tool (DST) shows impact of land use change on ecosystem services in our 3

study area. It is used to integrate the results of this project, and show these to the decision makers with a visualization and friendly interface, supporting them to make more reasonable decision.

Decision support tools are developed by software of Adobe Dreamweaver, computer language as HTML and JavaScript are used to develop tools. It is running on windows platform, using IE browser to open it. These tools consist of 5 parts, including study area, LUCC, assessment of ecosystem services, scenarios (only in Poyang Lake wetlands) and achievement of our project.

Framework of decision support tools is designed as follows:

In the "study area" part: It is the introduction of the study area of the 3 countries. Contents are including geographical positions, nature, social, economic situations of the study areas.

In the "LUCC" part: Firstly, using the form of table and explanatory notes, we show the overall trend of land use/cover change of the 3 study sites in the past 10—20 years, and the driving forces which make land use/cover changes. Secondly, using the form of table, geographical maps and explanatory notes, we show LUCC trends in the past 10—20 years of each study site.

In the "assessment of ecosystem services" part: Firstly, using the form of table, we show the overall change trends of ecosystem services of each site in the past 10—20 years. Secondly, using the form of table, geographical maps and explanatory notes, we show ecosystem services change trends characteristic in the past 10—20 years for each study site.

In the "scenarios" part: We chose Poyang Lake wetlands as the study example. We show scenarios, scenarios parameters and result which get from FoPIA. We also show the habitat map of the migratory bird which get from InVEST model in typical villages.

In the "achievement" part: Showing articles that we have publishes or coming publish, which including articles, master/doctor thesis, progress report base on the project.

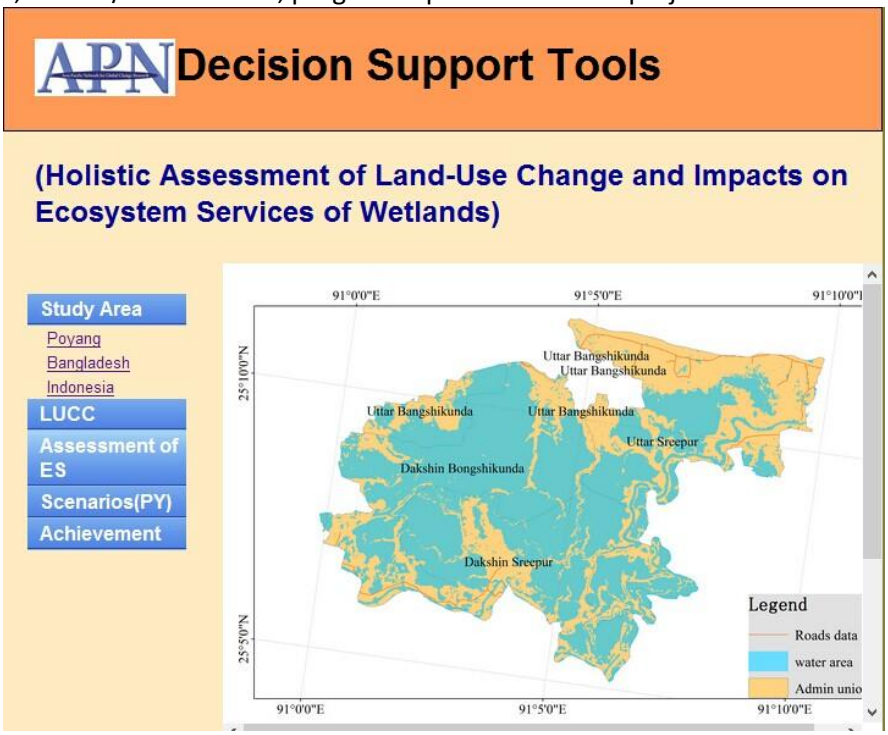


Figure 35 Interface of the Decision support tools

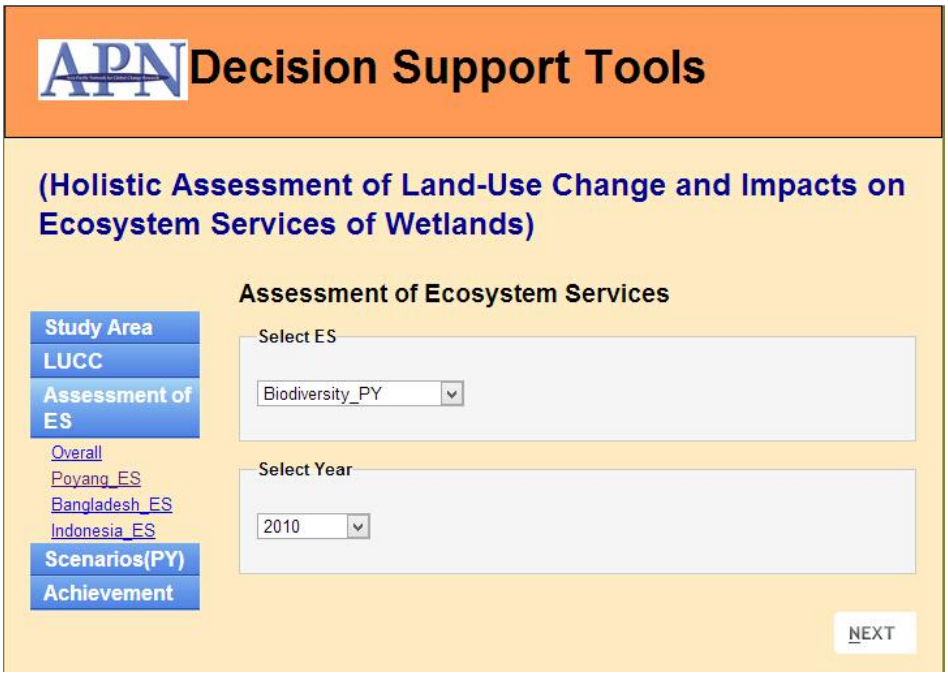


Figure 36 Selecting interface of assessment of ecosystem services.

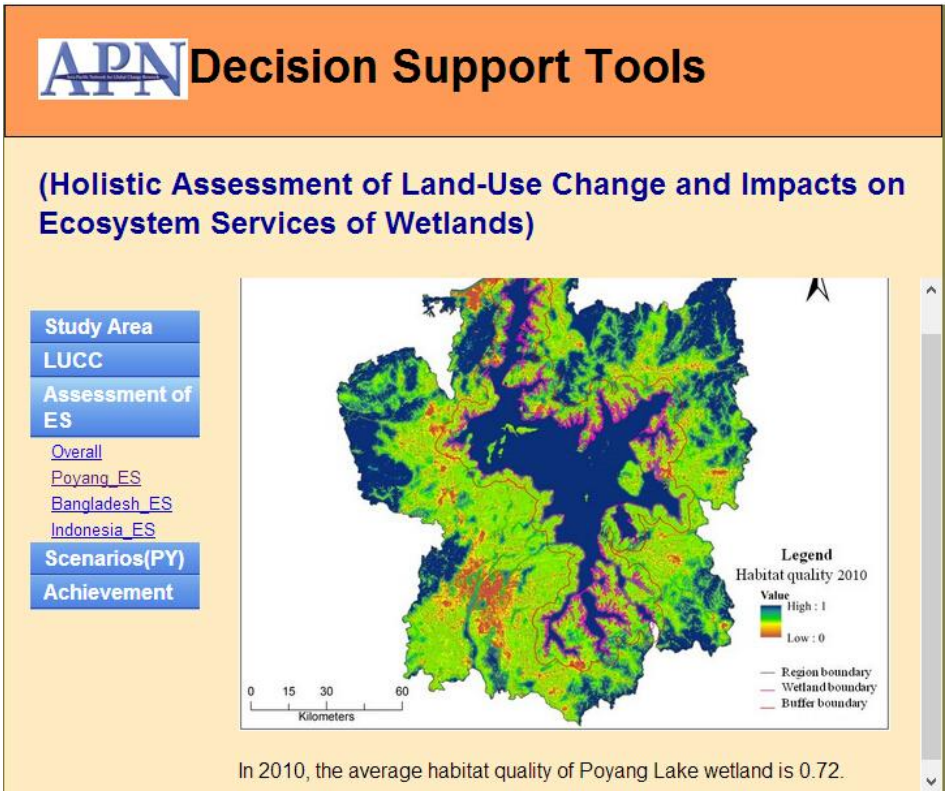


Figure 37 Result of ecosystem services of (Biodiversity in Poyang Lake wetland)

3.3 Discussions

3.3.1 Importance of your findings, in light of the overall study aims

(1) In Poyang lake wetland of China, following aspects are significant for the findings

a) Land use/cover types and changes: Cultivated land, forest and wetland are the most important land use/cover types in Poyang Lake wetland, which covers 34.76%, 28.22% and 26.56% of the

whole area in the year 2010. During 2000 to 2010, forest land increased by 2.06% because of project returning farmland to forest. Whereas, for the reason of reclaim land from a lake, the area of wetland presented decrease in a degree, but project of returning farmland to lake had made things less worse. Cultivated land decreased sharply because of returning farmland to lake, returning farmland to forest and construction occupying.

From the typical village study, we find that intensify of land use in Poyang lake wetland had been decreased (average 4%), and the vegetation coverage had been increased (average 10%). Land use/cover change (LUCC) which caused by ecological conservation projects is the main LUCC type in Poyang Lake wetland. Multiple cropping index of the paddy field had been decreased (average about 15%, data from household questionnaire).

b) Main driving forces of land use change: During the year 2000 to 2011, precipitation had undergone trends of decrease. Precipitation decreasing can make some wetland which have low water content to become grassland. extraordinary rainstorm in 1998 caused "returning farmland to lake" (RFL) policy into effect, which made remarkable change of land use such as many cultivated land being change into wetlands.

From the expert discussing, policy, industrialization, urbanization and dam construction are the main anthropogenic factors of land use change. From the typical village study, the main LUCC is caused by new built homestead, cultivated
land abandon, transformation from paddy field into dry land, fish ponds construction and eco-projects, which took more than 95% of the total changed area.

c) Impact of land use change on main ecosystem services in the wetland: On account of the calculation of InVEST Model, in 2000, the average quality of habitat of the whole Poyang Lake wetland was 0.69, and it went up to 0.72 in 2010 with a growth of 4.53%. And from view of two typical villages, the model's calculations show that the average habitat quality in and around Chenlang in 2000 was 0.48, and that this increased by 18.8% to 0.57 in 2012. For Yuanlong village, the InVEST calculations showed that the average habitat quality increased from 0.44 in 2000 to 0.65 in 2012 (by 47.7%). Ecological projects and some other human activities such as cultivated land discounting are the main reason for such changes.

Also on account of the calculation of InVEST model, the amount of soil erosion of Poyang Lake wetland decreased from 16.50 Mt in 2000 to 15.45 Mt in 2010 with the amount of 1.05 Mt decreased as 6.39%. Project of returning farmland to forest had made big construction to this result.

(2) In GSBR of Indonesia, following aspects are significant for the findings

By this research, we know that the needs and biological physical impulses make humans must adapt their self with the environment, by changing the land use due to the economic and physical circumstances. In terms of land use change, land use change patterns of other uses (forest, shrub, open land and fields) into houses, rubber plantation, village facilities are very dominant in some areas, such as Temiang Village and tasik Betung village.

(3) In Tanguar Haor of Bangladesh, following aspects are significant for the findings

This study has intensively assessed the land use changes and their impacts on major ecosystem services of Tanguar haor wetland of Bangladesh. This wetland has local and national importance because of its diversified services and benefits but currently services are being depleted noticeably. This study has identified the major land uses and their changes over time by analysis of satellite images over time and opinion of communities and local experts. Among the changes of different land uses, the main visible change was the change of water bodies where water bodies were transformed to crop land, mudflat, settlement and unproductive swamp forest. Because of the good water bodies, this ecosystem was considered as the treasure house of diversified resources especially fishes and bird habitat as well as drinking water and income of the local people that are being depleted over time. The analysis of satellite image of the study site supported the field records on the changes of land use pattern. The main reasons for these changes were identified as

sedimentation/siltation, lack of initiative for dredging, climate change and several anthropogenic activities. Among the anthropogenic activities, over-exploitation of resources, use of excessive agro-chemicals in rice cultivation, population pressure and new settlement, water pollution in various ways were the major factors. As a result of various natural and anthropogenic driving forces, most of the ecosystem services such as fish, food, fuel wood, fiber, drinking water etc have already been decreased in varying degrees over time. Considering the worst situation of this important ecosystem, the government has undertaken the free access of the people for harvesting resources and promoted social forestry activity for improvement of swamp forest. These might have positive sign to conserve wetland ecosystem and create better ecosystem services for the haor communities. The other initiative that should be undertaken to conserve resources and improve the services are creation of awareness among the peoples, alternate livelihood activities and regular dredging of the beels and rivers.

3.3.2 Synthesize what has (and has not) been learned about the problem and identify existing gaps

In Poyang lake wetland of China, we are most focus on ecosystem services of biodiversity and soil retention, some other types of important ecosystem services such as flood regulation and food supply are not studied in detail. Parameters in InVEST model are most getting from literature but not getting from measurement. Therefore accuracy could be better to some extent.

In Indonesia, effective dissemination of the land use change effect by communication strategy has not been much learned in this research.

In Bangladesh, some existing gaps can be show as follows: (1) The study site (Tanguar haor) covers big areas (10000 hectares) while this study was conducted in a specific area (3 villages and surrounding areas) only. It would have provided more authentic information if we could do work at least 10-12 different places. (2) This wetland is located at the periphery of the country (north-eastern border site). The communication facility with the location was very poor that hampered the easy movement of the researchers. (3) The outcomes of the study were accomplished based on the people opinions and secondary data base. Long term field monitoring of resources both in dry and wet seasons could have provided more realistic information.

3.3.3 Recommend areas for further work

In Poyang lake wetland of China: areas in the upstream of Yangtze river is worth to study for the further work because the three gorges was built in 2003 and it was using to generate electricity and regulating flood, which made big influence on ecosystem services in Poyang Lake.

In Giam Siak Biosphere Reserve of Indonesia: since the consorcium of the researcher in Kalimantan was established, and have commitment to work together in all ecosystem types in Kalimantan, so we proposed West Kalimantan to support Kalimantan biodiversity database. East Indonesia such as Sulawesi, Maluku and other Island in East Indonesia also interesting place to be explored due to lack information of biodiversity. Papua is also need to be explored more because still needed expidition in that area.

In Tanguar haor of Bangladesh: a number of actions for future work have been listed for appropriate resources management of Tanguar haor and maintaining the livelihood of the communities. Among these, priority areas are: Intensive program for assessment of resources of the whole haor areas; Development of policy and techniques for conserving the natural resources for sustainable uses in view of both natural and anthropogenic threats; Awareness building program among the local people on the importance of resources and the ecosystem services for their livelihoods; Awareness creation initiatives among the people for protection of water from pollution; Step for dredging the rivers/ beels for maintaining water retention capacity and water flow/movement processes; Create alternate income generating opportunities such as ‘ecotourism’ to reduce the dependency of the people on haor wetland.

4 Conclusions

(1) In the Poyang Lake area of China, we get the conclusions that:

Using InVEST model to analysis the impact of LUCC on biodiversity shows that: because of the increasing of forest land and grass land, which supply high weigh bio—habitat, making the average quality of the biodiversity increasing by 4.53%. From the micro-scale view of village, the migratory birds—the indicative biological of Poyang wetlands, the habitat quality of the two typical villages has increased by 18.75% (Chenlang) and 47.73% (Yuanlong).

Using InVEST model to analysis the impact of LUCC on soil retention shows that: From the micro-scale view of Poyang Lake wetlands, in the recent 10 more years, a large amount of cultivated land altered to forest land, which make land cover rate and sediment retention efficiency higher than ten years ago. As a result, the total soil erosion has been decreased by 1.05 million tons and the total soil retention had been increased by 0.28 million tons.

From analysis by PRA, impacting by LUCC, the supply services of ecosystem services in Poyang Lake wetland had trends of decrease, and regulating, cultural and supporting services hand trends of increase, especially biodiversity of supporting services and soil retention of regulating services.

According to PRA and FoPIA results, the future sustainable development policy scenarios of Poyang wetlands can be assumed to be conservation scenario, construction scenario and baseline scenario.InVEST modlel shows that in conservation scenario, forest, grassland and wetland will be increase, and habitat quality and siol retension function of Poyang Lake wetland will be improved.

(2) In the Giam Siak Biosphere Reserve of Indonesia, we get the conclusions that:

The study has provided recommendations and strategies in understanding the role of land use change and drivers, and also provided suggestions allowing policymakers to evaluate the effect of land use change.

(3) In the Tanguar haor wetland of Bangladesh, we get the conclusions that:

Bangladesh Relevant appropriate methods and techniques including formal and informal methods (PRA, FGD, survey, discussion meeting), and materials such as secondary data, analysis of satellite images, statistics data, meteorological data were used to understand to land use changes and impacts on ecosystem services of Tanguar haor wetland.

In this study, major land use changes were identified where the main visible change was the transformed of water bodies to crop land, mudflat, settlement, and unproductive swamp forest.

Reasons/ driving forces for these land use changes were documented. The main natural forces were sedimentation/siltation, absence of dredging, climate change, and the anthropogenic forces were over-exploitation of resources, use of excessive agro-chemicals in rice cultivation, population pressure and new settlement, water pollution.

The impacts of land use changes on ecosystem services of Tanguar haor wetland were assessed. It has been found that most of the ecosystem services such as availability of fish, food, fuel wood, fiber, drinking water etc. have already been decreased in varying degrees over time.

Potential problems and future areas of work for conservation of resources and maintaining the livelihood of the local people have clearly been highlighted in the report.

Skill and capacity of the young scientists and researchers involved with this project have been enriched and they can now carry-out the similar study with more accuracy.

As it was a regional project, linkage among the scientific community of Bangladesh (Bangabandhu Agricultural University), China (Chinese Academic Sciences, Beijing) and Indonesia (Research Centre for Biology, Bogor) has been well established through joint field visits in the involved countries and discussion meetings.

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Appendix

Conferences/Symposia/Workshops

Agenda/Programme (including title, date and venue)

Participants list (comprising contact details of each participant, including organisation, address, phone number, fax number, and email address)

Agenda for kick off meeting

APN Workshop–IGSNRR, Beijing, 28--30 December 2011

Project title: Holistic assessment of land-use change and impacts on ecosystem services of wetlands
Venue: IGSNRR, Conference Room 2204, 11A Datun Road, Chaoyang District

28th DEC
Arriving at the hotel.
Hotel name: ShenZhou Business & Travel Hotel
Address: No.5 Minzuyuan Road, ChaoYang district, Beijing.
29th DEC Morning
9:00
Lin Zhen, PhD, Professor, Deputy Director of Department of Resource Ecology and Bioenergy ResourcesOf IGSNRR of CAS. Opening remarks and project Introduction.
9:30—12:00 Report and discuss
9:30
Chuanzhun Sun, Ph D Candidate of IGSNRR.
Theme: Land-use change of Poyang Lake area
(Coffee break 10:10—10:30)
10:30
Ms Farah Aziz, Senior Logistics Officer, United Nations World Food Programme (UN WFP), Dhaka, Bangladesh.
11:10
Prof Dr Joeni S. Rahajoe, Cibinong Science Center, Indonesia.
11:50—12:00 discuss
12:00-14:00 launch
Restaurant name: AoBeiTianXiang restaurant
Address: South of Olympic village, Beichen west road, Chaoyang District.
29th DEC Afternoon:
14:00—17:00 Report and discuss
14:00
Prof Dr Giashuddin Miah, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Bangladesh.
14:40
Prof. HeQing Huang, Institute of Geographic Sciences & Natural Resources Research (IGSNRR), Chinese Academy of Sciences (CAS).
(Coffee break and photo: 15:20—15:40)
15:40

Prof Dr Bangyou Yan, Deputy Director of Office of the Mountain-River-Lake Development Committee of Jiangxi Province.
16:20—17:00 Discuss
18:00-20:00 Supper dinner
Restaurant name: MeiZhouDongPo restaurant
Address: GuoAo village, Lincui east road.
30th DEC Morning:
9:00—9:40 Report and discuss
9:00
Prof Dr Kikuko Shoyama, Center for Global Environmental Research, National Institute for Environmental Studies, Japan.
9:40—11:30 Participatory discussion
11:30-12:30 launch.
Restaurant name: AoBeiTianXiang restaurant
Address: South of Olympic village, Beichen west road, Chaoyang district.
30th DEC Afternoon.
13:30
Discuss the possible publication.
14:30
Summary of the meeting. By Prof. Lin Zhen.
15:00
Closing.

Table 23 List of participants in the kick-off meeting in Beijing (on 29—30 December 2011)

Name	Position	Affiliation	Email
Lin Zhen	Professor	IGSNRR	zhenl@igsnrr.ac.cn
MD Giashuddin Miah	Professor	Bangabandhu Sheikh Mujibur Rahman Agricultural University, Bangladesh	giash1960@gmail.com
Joeni Setijo Rahajoe	Professor	Cibinong Science Center, Indonesia	joenisr@indo.net.id
Shoyama Kikuko	Dr, Research Associate	National Institute for Environmental Studies Center for Global Environmental Research, Japan.	shoyama.kikuko@nies.go.jp
Farah Aziz	Senior Officer	United Nations World Food Programme (UN WFP), Bangladesh	Farah.Aziz@wfp.org

Name	Position	Affiliation	Email
Bangyou Yan	Professor Deputy Director	Office of the Mountain-River-Lake (MRL) Development Committee of Jiangxi Province, PRC.	ybangyou@sina.com
Yuping Yan	Research Associate	Office of MRL Development Committee of Jiangxi Province	yanyp1st@yahoo.com.cn
Fengwen Bai	Division Director	National Bureau of Survey and Mapping	fwbai64@sina.com
Heqing Huang	Professor	IGSNRR	huanghq@igsnrr.ac.cn
Luguang Jiang	Associate Professor	IGSNRR	jianglg@igsnrr.ac.cn
Chuanzhun Sun	PhD student	IGSNRR	subject_111@126.com
Xin Long	PhD candidate	IGSNRR	longx.09b@igsnrr.ac.cn
Bingzhen Du	PhD candidate	IGSNRR	dubingzhen@hotmail.com
Xiaochang Cao	M.S. candidate	IGSNRR	caoxc.09s@igsnrr.ac.cn
Ruizi Wu	M.S. student	IGSNRR	wuruizi007@sina.com

Table 24 Agenda for mid-term workshop in Dahka

Time	Topic	Speaker/Place
Nov 26, 2012: arrival to Dhaka		
Nov 27, 2012: preparation of the workshop and pre-meetings		
28-Nov-12		
9:00-9:10	Welcome and greetings	GiashuddinMiah
9:10–9:50	Overview of the Project- Report of Case Studies of China site	Lin Zhen
9:50-10:30	Report on Case Studies of Indonesia site	Joeni S. Rahajoe
10:30-10:40	Tea Break	Hotel Lobby
10:40-11:20	Report on Case Studies of Bangladesh site	GiashuddinMiah
11:20-11:40	Expectation and Gaps	Lin Zhen
11:40-12:20	Discussion/Future Planning (Continue after Dinner)	All members
12:20-13:00	Lunch	Hotel Cafeteria
13:20	Left for Srimangal (for field Visit)	
18:00	Arrival in Guest house at Srimangal	Srimangal
18:00-19:00	Dinner	Restaurant
19:00-20:00	Program Planning and Planning or Next Day	Hotel
Nov. 29-30, 2012: Field surveys		
Dec. 1, 2012: Departure		

Table 25 List of participants in the progress meeting in Dahka (on 23—24 Nov 2012)

Name	Position	Affiliation	Email
Lin Zhen	Professor	IGSNRR	zhenl@igsnrr.ac.cn
MD Giashuddin Miah	Professor	Bangabandhu Sheikh Mujibur Rahman Agricultural University, Bangladesh	giash1960@gmail.com
Joeni Setijo Rahajoe	Professor	Cibinong Science Center, Indonesia	joenisr@indo.net.id
Farah Aziz	Senior Officer	United Nations World Food Programme (UN WFP), Bangladesh	Farah.Aziz@wfp.org
MR.Minnazamed	Assistant Professor	Bangabandhu Sheikh Mujibur Rahman Agricultural	

Table 26 Agenda for final report in Indonesia
Botany Division-Research Center for Biology LIPI, June 24th—27th 2014

Time	Tentative Agenda	Person	Notes
June 24 2014: Lin Zhen and Giash arrival to Jakarta			
June 25th 2014			
10.00—10.15	Welcome remark	Joeni S.R	
10.15—10.45	Indonesian Progress Report: Study Site in Giam Siak Biosphere Reserve & Discussion	Vera B.L.S, Joeni S.R & M. Fathi Royyani	
10.45—11.30	China Progress Report & Discussion	Prof. Lin Zhen	
11.30—12.15	Bangladesh Progress Report & Discussion	Prof. Giash	
12.15—13.15	Break		
13.15—18.30	General Discussion & Wrap up, and discussion for next planning, Closing	Prof. Lin Zhen	
Thursday, June 26th 2014			
08.00—10.00	Field Trip to Rawa Danau	Joeni S.R Vera Fathy	because If we go to the field work location to Giam Siak in Sumatera

		Lin Zhen Giash Local officials	Island it is need 4 days trip
10.00—12.00	Field Trip in Rawa Danau		Introduction of Rawa Danau Natural Reserve is attached in below box.
12.00—13.00	Break		
13.00—14.00	Field Trip in Rawa Danau		
14.00—16.00	Going back to Bogor		
Thursday, June 27 th 2014			
08.00—10.00	Field Trip to Bogor Botany Garden		
10.30—11.30	Prof Lin going to the Airport Jakarta		

Table 27 List of participants in the final meeting in Jakarta
(June 24-27 2014)

No	Name	Title	Affiliation	Email
1	Siti Susiarti	Professor	Cibinong Science Center, Indonesia	
2	Vera Budi Lestari Sihotang	Dr	Cibinong Science Center, Indonesia	verbudl@gmail.com
3	Leberina Kristina Ibo	Dr	Cibinong Science Center, Indonesia	
4	Septiani Dian Arimukti	Dr	Cibinong Science Center, Indonesia	
5	Purwanto	Professor	Cibinong Science Center, Indonesia	
6	Eko Baroto Walujo	Professor	Cibinong Science Center, Indonesia	
7	Joeni S. Rahajoe	Professor	Cibinong Science Center, Indonesia	joenisr@indo.net.id
8	Giashruddin Miah	Professor	Agricultural University, Bangladesh	giash1960@gmail.com
9	M. Fathi Royyani	Dr	Cibinong Science Center, Indonesia	fathi.royyani@gmail.com
10	Lin Zhen	Professor	IGSNRR	zhenl@igsnrr.ac.cn
11	Laode Alhamd	M.S.	Cibinong Science Center, Indonesia	

BOX: Introduction to Rawa Danau Nature Reserve

Rawa Danau Nature Reserve has a specific type of mountain swamp ecosystem. Rawa Danau Nature Reserve has the principal function of preserving the diversity of plants, animals, and ecosystems as well as the life support system of protected areas. Based on the work area, the management of Rawa Danau Nature Reserve area is part of the working area Section III Region Conservation, Natural Resource Conservation Center in West Java I.

Location: Based on the Government Besluit No. 683 dated 16 November 1921, a broad of Rawa Danau Nature Reserve is 2500 ha. Geographically Rawa Danau Nature Reserve lies between 6'08" to 6'11" latitude and 105'56" to 106'04"E with an altitude of 90 to 225 meters above sea level. Based on public administration Rawa Danau Nature Reserve is included in the region of 3 Padarincang districts namely, Pabuaran & Mancak, Serang, Banten Province. In the North and East, Rawa Danau Nature Reserve bordering with Tukung Gede Mountain, in the south, bordering with Kalumpang village, and in the western side bordering with Ciraab village. Rawa Danau Nature Reserve is the estuary of several rivers, namely S. Cimanuk (Cikalumpang), Cibugur, Cisawara, Cisaat, Cidangiang, Citeureup, and Cipadarincang. Ecosystem types of Rawa Danau Nature Reserve consists of aquatic vegetation, marsh vegetation, mountain lake waters and mountain rain forest vegetation.

Accessibility: To reach the Rawa Danau Nature Reserve area can be reached from the town of Serang to Padarincang then to the Kalumpang village, and to the location. Rawa Danau Nature Reserve can also be reached via Mancak, Cikedung village, and then directly to the site.

Activities in Region: According to Law No. 5 of 1990, Conservation of Natural Resources and Ecosystems has activity in research and development, science, education, and other activities that support cultivation.

Funding sources outside the APN:

Institute of Geographic Sciences and Natural Resources Research (IGSNRR) of Chinese Academy of Sciences (CAS) has provided in-kind supports and staff time and salary;

The supporting budget from National Budget for Research Center for Biologi of Indonesia;

The Department of Agroforestry and Environment, BSMRAU has provided in-kind supports through office space, computer facilities, audio-visual facilities and local transport supports to accomplish the research work. The staffs of the department provided all necessary support and cooperation whenever needed. The concerned Principal Investigation and other scientists gave their valuable time without any salary/honorarium.

List of Young Scientists

Include brief detail (full name, involvement in the project activity) and contact detail (name of institution/country and email address) of your scientists involved in the project. Also include short message from the young scientistsabout his/her involvement in the project and how it helps develop/build his capacity and the knowledge he gained.

Chuanzhun Sun , from Institute of Geographic Sciences & Natural Resources Research (IGSNRR),

Chinese Academy of Sciences (CAS), PR China. Email: suncz.11b@igsnrr.ac.cn. He is in charge of data collecting and analysis in Poyang Lake region, conduct of evaluation and simulation (by InVEST model) of land use change impact on ecosystem service. Than draft out progress report and final report under the guidance from Prof. Zhen. Chuanzhun Sun is a PHD student whose research direction is land use/cover changes impact on ecosystem services. He is also good at using GIS methods to analysis data. In this project, above-mentioned background helps him to contribute to this project.

Chao Wang, from Institute of Geographic Sciences & Natural Resources Research (IGSNRR), Chinese Academy of Sciences (CAS), PR China. Email: wangc.12b@igsnrr.ac.cn. He helps finish the field study and household questionnaire. Chao Wang is a PHD student whose research direction is ecosystem function in developing region. He has unique insight of developing in our study area, which is also a developing region. He help analysis factor impacting on ecosystem services.

Bingzhen Du, from Wageningen University. Email: dubingzhen@hotmail.com. She helps organize the kick-off meeting. Bingzhen Du is a PHD student whose research field is ecosystem assessment. She learnt some GIS techololy in this project and it is useful for her PHD thesis writing.

Jie Hu, from Institute of Geographic Sciences & Natural Resources Research (IGSNRR), Chinese Academy of Sciences (CAS), PR China. Email: hujie0214@126.com. She helps collecting second hand data of this project. Jie Hu is a PHD student whose research field is national culture assessment. She can gain knowledge of the relationship between national culture and ecosystem services.

Mohammad Fathi Royyani. Botany and Microbiology Building, Cibinong Science Center, JL. Jakarta-Bogor KM 46, Cibinong, Bogor, West Java, Indonesia 16911. Telephone no. 62-21-8765066, 62-21-8765067 Facsimile no.62-21-8765063. E-mail address moha036@lipi.go.id and fathi.royyani@gmail.com. Web site address www.lipi.go.id, www.biologi.lipi.go.id. This research has developed his capacity to make holistic assesment of land use change and impacts on ecosystem services. Also, he learned that there is a need of making ecosystem assesment for supporting the recommendations of the stake holder.

Vera Budi Lestari Sihotang. Botany and Microbiology Building, Cibinong Science Center, JL. Jakarta-Bogor KM 46, Cibinong, Bogor, West Java, Indonesia 16911. Telephone no. 62-21-8765066, 62-21-8765067 Facsimile no.62-21-8765063. E-mail address vera002@lipi.go.id and verbudl@gmail.com. Web site address www.lipi.go.id, www.biologi.lipi.go.id. This research has developed her capacity in analyze land use change effect in certain area. Also, she have learned that to see what the effects of the land use change, we need to know the indirect and direct factors of it.

Bayu Arief Pratama. Botany Division, Research Center for Biology – LIPI, JL. Jakarta-Bogor KM 46, Cibinong Science Center, Kab. Bogor, West Java, Indonesia 16911. Telephone no. +62-21-8765066, +62-21-8765067 Facsimile no. +62-21-8765063. E-mail: bayuariefpratama@yahoo.com, bayu009@lipi.go.id. Website: www.lipi.go.id, www.biologi.lipi.go.id. In this project she was involved in biodiversity analysis and GIS. From this project, she also learned how to determine the direction of development of a region that is in line with conservation efforts.

Minhaz Ahmed. Assistant Professor, Department of Agroforestry and Environment, BSMRAU, Gazipur. E-mail: minhaz.afe@gmail.com

Md. Shamim Hossain. Assistant Professor, Department of Entomology, BSMRAU, Gazipur. E-mail: shamim.bsmrau@gmail.com

Md. Riaj Uddin. Graduate Student, Department of Agroforestry and Environment, BSMRAU, Gazipur.

Above 3 young Bangladesh scientists had worked for several years. The theme and area of study was new to them. They gained new knowledge on this issue. They also learned different methods and techniques through applying in this study and accomplished good outputs.

Glossary of Terms:

Asia-Pacific Network for Global Change Research, APN
Ecosystem service (ES)
Framework of Participatory Impact Assessment, FoPIA
Focus Group Discussion, FGD

Giam Siak Biosphere Reserve in Indonesia, GSBR
Integrated Valuation of Ecosystem Services and Tradeoffs, InVEST
International Geosphere-Biosphere Program,IGBP
International Human Dimension Programme on Global Environmental Change, IHDP
International Union for Conservation of Nature, IUCN
Land use/cover change, LUCC
Global Land Project, GLP
Local Government Engineering Department, LGED
Participatory rural appraisal, RRA
Returning farmland to lake, RFL
Returning farmland to forest, RFF
World Food Program, WFP
United Nations Environment Programme, UNEP

In the Appendix section, the report may also include:
Actual data or access to data used in the study
Abstracts, Power Point Slides of conference/symposia/workshop presentations

Please refer to the separate folder named as “Presentations”.

Conference/symposium/workshop reports

(1) Workshop presentations:

- Kick off meeting presentations: Lin Zhen, Joeni, Giam, Luguang Jiang, Bangyou Yan, Yuping Yan, Fara Aziz
- Mid-term presentations: Lin Zhen, Joeni, Giam
- Final workshop presentations: Vera, Giam, Lin Zhen

(2) Conference abstract and presentations:

- Lin Zhen at the 2nd GLP Open Science Meeting in Berlin in March 2014
- Lin Zhen/Jie Hu/Chuanzhun Sun at the GLP Asia Conference in Taipei in Sept 2014 (Oral presentation and poster)

The report is to be submitted **one month before the end the Contract Period**in the following formats:

1. By airmail to the address below:
   a. **Soft Copy – 2 CD-ROMS**, appropriately labeled and covered using the design and information on the cover page of the Report Template
   b. **Hard Copy – 2 bound copies** appropriately labeled and covered using the design and information on the cover page of the Report Template

Dr. Linda Stevenson
Head, Communications and Scientific Affairs Division
APN Secretariat
4F East Building
1-5-2 Wakinohama Kaigan Dori
Chuo-Ku, Kobe 651-0073 JAPAN

2. By e-mail and addressed to Dr. Stevenson (lastevenson@apn-gcr.org)and Dyota Condrorini(dcondrorini@apn-gcr.org).
   Kindly note that our server can also receive attachments of up to 25MB file size. In case that the final project report file size exceeds 25MB please try any of the following options:

   a. For a larger file size please try the following:
      - Upload on your institution's ftp server and provide to us the download details (i.e. IP address, login details, etc)
      - Send through any of the free file hosting available in the internet. Please note that these free file hosting save your files for a limited number of days so it is very important to notify us immediately. Some of these are the following:
        - http://www.filefactory.com/
        - http://www.mediafire.com/
        - http://www.yousendit.com/
        - http://www.dropbox.com/
3. A separate **CD** containing other project outputs (i.e. publications, photos, etc)