



Promoting Upstream-downstream Linkages Through Integrated Ecosystem Management in the Greater Mekong Subregion



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Purpose

In the context of supporting biodiversity conservation, sustainable development, and poverty reduction, this policy paper portrays the critical role that ecosystem management and ecosystem services can play in the Greater Mekong Subregion (GMS). Ecosystem management is *“an integrated process to conserve and improve ecosystem health that sustains ecosystem services for human well-being”* (UNEP, 2009). The IUCN defines it as *“a process that integrates ecological, socio-economic, and institutional factors into comprehensive analysis and action in order to sustain and enhance the quality of the ecosystems to meet current and future needs”* (IUCN, 2011). Ecosystem management embraces an interdisciplinary approach that highlights connections between ecological, social-cultural, economic and institutional structures. Underlying the approach is the explicit goal to sustain ecosystem composition, structure, and function while providing for human needs (Grumbine, 1994, Layzer, 2008). Critical to this is ongoing research and monitoring of ecological interactions and processes, and a collaborative, adaptive approach to planning.

We highlight the importance of integrating ecosystem management into national policy-making across the upstream and downstream regions of the Mekong River¹. The GMS includes Yunnan and Guangxi provinces in Southwest China and the five countries of Southeast Asia: Cambodia, Lao PDR, Myanmar, Thailand and Vietnam (Cao et al., 2001). It covers over 2.6 million square kilometres and is a growing economic powerhouse and rich in globally important biodiversity (ADB, 2005).

We also argue strongly that integrating ecosystem management into policy-making would expedite the process of ‘green economy’ development in the GMS. UNEP defines a Green Economy as one that results in *“improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities”* (UNEP, 2011). Both economic and ecosystem issues are increasingly transnational in the GMS and to be effective, new policies will need to be integrated across nation-state boundaries.

In this paper, we evaluate the status of the ecosystem approach throughout the GMS by identifying challenges and opportunities to its implementation through transnational institutions. We develop links between ecosystem management and the development of a sustainable ‘Green Economy’. Finally, we offer recommendations to support the further development of the ecosystem approach in the GMS.

Our aims are to: (i) demonstrate the foundational significance of ecosystems in supporting economic growth in the GMS; (ii) illustrate to GMS policy makers the challenges and opportunities in adopting integrated ecosystem management; and (iii) recommend actions for integrating ecosystem management into national policy-making throughout the lower and upper reaches of the Mekong River.

Key Messages

- There is an urgent need to integrate an ecosystem management approach into national policy-making in the GMS.
- There is a need to develop, integrate and coordinate ecosystem management policies within and between the different countries in the subregion.
- In order to adopt an ecosystems approach to policy-making, institutional capacity in the GMS needs to be enhanced. Monitoring and evaluation of ecosystem processes and dynamics should be integrated to provide a sound scientific basis for policy-making.

We also argue strongly that integrating ecosystem management into policy-making would expedite the process of ‘green economy’ development in the GMS

¹ The upstream part of the Mekong River in China is referred to as the Lancang River.

In the last two decades, economies of GMS countries have been growing much faster than the rest of the world

- Valuation of ecosystem services and its inclusion in policy-making needs to become a common goal across the GMS.

Rationale

Intersected by a waterscape of rivers, the GMS encompasses a diverse range of ecosystems from coasts and lowland plains (<300 m asl) up to high alpine zones (>3000 m asl). Subject to a monsoonal climate, these landscapes are dominated by diverse vegetation mosaics, including saltwater mangroves, lakes and wetlands, crop lands and home gardens, temperate and tropical forests, and high elevation pastures. GMS ecosystems harbour some of the richest biodiversity in the world, while providing more than 300 million people with ecosystem services upon which their diversified livelihoods depend (GMS-EOC, 2011).

In the last two decades, economies of GMS countries have been growing much faster than the rest of the world. The growth rate of the subregion in 2010 was 7.4%, twice the world average (IMF, 2010). Development has put increasing pressure on critical ecosystems as the rapid expansion of infrastructure brings land use changes to the GMS (FAO, 2010). Recent debates among GMS countries have focused on the commercial exploitation of natural resources over the need to promote sustainability of ecosystems and the services they provide (Dosch, 2010).

The GMS is expected to be highly vulnerable to climate change (Mainuddin et al., 2010). It is projected that by 2030, the Mekong River could see a basin-wide temperature increase of 0.79°C, with even greater increases in the north (Eastham et al., 2008). This projection is the median of Global Climate Model simulations and increases have relatively small levels of uncertainty (Eastham et al., 2008). Temperature increases are expected to be accompanied by an annual precipitation increase of 20 cm, predominantly during the wet season. In the dry season, water stress is expected to affect parts of Northern Thailand and Tonle Sap in Cambodia. Changes in precipitation patterns may result in reduction of agricultural productivity and local water shortages, challenging human livelihoods (Rerkasem, 2011). Sea level rise and typhoons of higher intensity are also projected to increasingly threaten densely populated low-lying coastal areas in the Mekong Delta (Shaw, 2006, Thuan, 2011). Some impacts of climate change on GMS ecosystems have already been documented. The most widely reported has been the reduction of glaciers and permafrost areas with strong implications for future water resources (Xu et al., 2009). Warm winters are shortening the growing season of alpine plants (Yu H et al., 2010); drought may threaten endemic plant species (Qiu, 2010). Floods in the GMS are already worsening with the greatest impact downstream in the Mekong mainstream (Eastham et al., 2008). Over the 21st century, these stresses are projected to grow with uncertain frequencies, magnitudes and directions (Grumbine et al., 2012). Climate change will amplify impacts of ongoing economic development to the GMS's terrestrial, freshwater, estuarine, and marine ecosystems (WWF, 2009).

Ecosystem degradation in the GMS is augmented by a number of socio-political factors. Countries in the subregion have traditionally adhered to different political ideologies and systems (Ahmed and Hirsch, 2000) and have had a history of political instability and wars. This has slowed development; in fact, three countries in the GMS (Lao PDR, Cambodia and Myanmar) are classified as 'least developed' by the UN (UN-DESA, 2011). Differences in political ideologies and relative stages of development also imply that policies introduced in the GMS are often fundamentally different in aims and implementation (Goh, 2004). These differences are reflected in national environmental policies. However, all countries share the GMS environment in common and the historical lack of coordination in policy-making and implementation among individual countries is leading to depletion of common resources.

The interdependent nature of the GMS is reflected across national development priorities, including food security. Box 1 shows the effect that ecosystem degradation and rapid development in the upper reaches of the Mekong may have on food security of Cambodia. This illustrates the intertwined relationships between GMS countries and how it is necessary to coordinate policy actions.

BOX 1: Fisheries in Cambodia

Fisheries play a very important role in Cambodia; the sector employs over 6 million people, many of whom are rural poor. Fish is an important part of diet among Cambodians who are among the highest per capita consumers of fish in the world. Annual fisheries production contributes over 12% of the country's total GDP. Of total freshwater fisheries, 60% comes from the Tonle Sap Lake. The sector in general and the lake in particular, and the ecosystem services which it provides are critical for the country's food production (Nam and Bunthang, 2011). However, this sector is now under threat from ongoing development in the Mekong watershed, which is causing pollution, soil erosion, and increased water usage. The cumulative effect of these on fish resources are significant (Ahmed and Hirsch, 2000).

Box 2 shows another illustration of environmental and economic linkages between countries in the GMS. The 2011 floods in Thailand have had a severe impact on global supply chains and the market for Information Technology goods in the subregion (Lawton, 2011). This is a classic example of climate-related disaster in one country leading to economic downturn in others.

BOX 2: Interlinkages: Economic impacts of climate related disasters between countries in the GMS

With globalization, the effects of environmental catastrophes in one part of the world can easily be felt across another. The situation is aggravated when countries in question are part of the same subregion. Prolonged floods in July-November 2011 in Thailand have proved this beyond doubt, as it has not only affected the economic output of that country but also threatened markets in other countries, especially China. China is the world's largest manufacturer of hard disk drives (HDDs) and Thailand is the second largest (Gao and Tuo, 2011). The floods have hit the operations of most HDD manufacturers in Thailand, thereby affecting global supply. This has been reflected in prices of HDDs in China, which have risen by over 50% since the floods began (Gao and Tuo, 2011). Price rises are expected to continue well into the first quarter of 2012. This is a classic case of how a climate related disaster in a neighbouring country affects productivity in another nation.

Taken together, these illustrations portray the interlinked nature of countries and management challenges that may arise. It is imperative that GMS governments develop policies to adapt to environmental change and maintain the flow of ecosystem services to ensure human well-being. These issues are trans-national; so it will be necessary for GMS governments to plan together, streamline policy-making and cooperate to address these issues.

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The ecosystem management approach seeks to perpetuate ecosystem services that support human livelihoods.

Ecosystem Management, Ecosystem Services, and Human Livelihoods in the GMS

The ecosystem management approach seeks to perpetuate ecosystem services that support human livelihoods. Functioning ecosystems offer several kinds of services: the production of food and water; the control of climate and disease; photosynthesis, nutrient and water cycling and crop pollination; and spiritual and recreational benefits (de Groot et al., 2002, MA, 2005). Ecosystems also provide valuable adaptation mechanisms to cope with climatic stressors.

Maintaining functioning ecosystems and the services they provide benefits all people, especially the rural poor. In the GMS, over 50 million people live on less than US\$1 per day and many of them depend on natural resources for their livelihoods (Johnston et al., 2010, Arthur et al., 2011). Conserving natural resources has significant positive impacts on the welfare of those living in poverty. For example, subsistence fishers and farmers require natural assets to survive. Yet, the poor often have the least ability to adapt – i.e. relocate, change land use, alter income source - if and when their way of life is threatened. The poor are also the most likely sub-population to lack basic shelter and sanitation and therefore are often the group most impacted by severe weather, floods and other climate hazards. Maintaining and protecting ecosystems can provide protection services for vulnerable populations. Ecosystem services are often beneficial at the local level so that conservation and restoration of natural ecosystems can help buffer those people who directly depend on ecosystem services against extreme weather and climate change impacts.

Preliminary Evaluation of the Status of Ecosystem Management in the GMS: Challenges and Opportunities

In order to analyse current implementation of ecosystem management across the GMS, a preliminary assessment using peer-reviewed and published literature was conducted. We reviewed organizations which were experimenting with applying ecosystem management principles to protect and enhance ecosystem services. Additionally, we sought to examine key institutions which were pushing for markets for ecosystem services. Using rough measures of geographic coverage and scope of ecosystem-based projects, we looked for organizations that were attempting to bring the ecosystem approach into conventional policy-making. Due to limited information that we could access, we were not able to review exhaustively government efforts. Our work was based on English references only.

Results show that though there are a large number of organizations that encourage ecosystem management in the GMS, there are no “organizational champions” for the approach and there are numerous implementation gaps in the subregion. Ecosystem management is not yet widely accepted or implemented within the GMS by any individual organization or state.

Efforts to integrate ecosystem management into national policy-making across the GMS face several challenges and opportunities.

Challenges

a. Knowledge Gaps

Within all GMS countries, there exist gaps in scientific understanding of the linkages between development plans and ecosystem management. Development efforts are poorly connected with maintenance of functional ecosystems. Country and basin-wide data on ecosystem management issues are often unavailable, so integrated policy-making is stymied. Detailed interdisciplinary studies and assessments that attempt to link science and policy between the upper and lower reaches of the Mekong River do not exist. There does exist broad realization of the importance of the ecosystem approach to secure key ecosystem services for sustainable development, but most critical ecosystems in the GMS remain unidentified and/or insufficiently studied. Existing research programmes are fragmented and, so far, cannot provide adequate baseline assessments to support informed policy-making. At the largest scale, the circulation models used to project global climate change have not yet captured complex effects of topography so that subregional climate projections remain unclear.

There are also knowledge gaps with respect to quantifying costs and benefits of ecosystem services. Accounting for natural capital for development is not yet featured in GMS policy-making. Without internal expertise on these technical matters, policy makers are not able to make informed decisions. There are also socio-economic knowledge gaps on links between ecosystem services and human livelihoods since little research has been conducted on these topics.

b. Policy Gaps

Serious gaps exist in the utilization and communication of scientific research outcomes for policy-making. For example, there is a lack of adequate knowledge of impacts of climate change and other stressors on ecosystems and livelihoods among policy makers within each country in the GMS.

Policy gaps also exist between individual countries in the GMS. The Mekong countries are at various stages of development, and this, along with varying political ideologies in each state, undermines integrated policy-making across the basin. This gap is exacerbated by a lack of science-based decision support systems within and between GMS countries. Countries have few viable and/or cost-effective strategies for pursuing ecosystem management at any scale from the local watershed to the entire subregion.

c. Capacity Gaps

There are a variety of GMS institutions working on ecosystem/environmental issues. The key element lacking is the integration of efforts among these stakeholders. While there is some degree of integration which has been achieved by efforts such as the Asian Development Banks' GMS Programme (ADB, 2005), there is much more to be done. Most key players do not coordinate their activities with other groups. For this to change, greater leadership within and between GMS groups and governments is needed.

Though many organizations and countries are keen to maximize economic development benefits with their neighbours, state institutions in the GMS are not yet strong enough to assess the costs and benefits of cooperation (WB, 2007). The World Bank has clearly identified that the GMS requires stronger institutions for ecosystem-friendly development (WB, 2007). Until this occurs, a major gap for integrating ecosystem management into GMS-wide policy-making and the integration of ecosystem services valuations into national and subregional policy-making will persist.

There are also knowledge gaps with respect to quantifying costs and benefits of ecosystem services.

There already exist several initiatives which could enable the integration of ecosystem management in the GMS.

Opportunities

An ecosystem-based approach can make significant contributions to planning in the GMS by introducing (1) protection of basic ecosystem structure and function based on science; (2) decision-making that is informed by primary stakeholders; (3) mapping and monitoring vulnerability based on communities' adaptive capacities; and (4) highlighting integrated ecosystem management for support of human livelihoods and adaptation to climate change. Overall, given climate change projections for the GMS along with the low resilience of human populations, the ecosystem approach could be applied as a framework to support adaptation-oriented and climate compatible development.

There already exist several initiatives which could enable the integration of ecosystem management in the GMS. Pivotal to this is the Mekong River Commission (MRC, 2011) which has generated a wealth of information of Mekong Basin countries. The Regional Climate Adaptation Platform for Asia funded by Swedish International Development Cooperation Agency is a useful knowledge sharing mechanism for climate change adaptation activities (SIDA, 2011). The Commonwealth Scientific and Industrial Research Organisation (CSIRO)- Australian Agency for International Development (AusAID) Mekong project is exploring possible future trajectories between food, water and energy driven by climate change, rapid land use change and urbanization (RfD, 2011). The German Federal Ministry for Economic Cooperation and Development (BMZ) /GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit) supported World Agroforestry Centre (ICRAF) "Making the Mekong Connected" project aims to develop carbon and biodiversity assets for landscapes in the Upper Mekong. Research networks including M-POWER (Mekong Programme on Water, Environment and Resilience) (M-POWER, 2011) supported by the Consultative Group on International Agricultural Research (CGIAR) Challenge Programme and Sumernet (Sustainable Mekong Research Network) (Sumernet, 2011) have also done considerable work on the Mekong River. Better integration of these ongoing initiatives would help to support future use of the ecosystem approach.

In addition, a host of new GMS development initiatives are in planning stages. Funders include the World Bank, Asian Development Bank, and Japan Bank for International Cooperation. The Chinese Ministry of Science and Technology has recently initiated an integrated survey of the GMS including water, land, biodiversity, and ecosystem services. This will generate new information for better management of ecosystems in the Basin.

The GMS countries are in early stages of adopting policies to combat climate change (ADB, 2009), and there exist opportunities to integrate ecosystem management into these efforts. This would enable countries to follow a low carbon development path using an ecosystem framework. If adoption of a Green Economy cost/benefit accounting was also done, this would aid ecosystem efforts and provide a path to more economic equity in the GMS. Owing to low climate resilience among people in the GMS, Ecosystem-Based Adaptation (EBA) and Community-Based Adaptation (CBA) approaches to climate change should be integrated wherever possible.

What is lacking throughout the GMS is integration of these diverse initiatives across national boundaries. There is a need to bridge gaps and establish a scientific baseline to understand environmental stressors within the subregion. Though the ecosystem approach encourages cost-efficient policies and development strategies that blend short-term needs with long-run targets, there is as yet little official support for it. Until there is sufficient political will, neither an ecosystem approach nor a Green Economy can be achieved in the GMS. Since we did not focus on state institutions and national barriers to the ecosystem approach, the next step for researchers will be to evaluate specific governments' capacity to provide leadership on this issue.

Developing a Sustainable Green Economy in the GMS through Ecosystem Management

There are many links between the ecosystem approach and development of a Green Economy. The goals of a Green Economy, 'improved human well being', 'social equity' and 'reducing environmental and ecological scarcities' cannot be met without maintaining healthy and fully functional ecosystems (UNEP, 2011a). Combining 'Green Economy' goals with ecosystem management would be useful in the GMS, where there is an urgent need to reduce poverty and build strong economies while also protecting the integrity of ecosystems.

These efforts would require both top-down and bottom-up strategies. From the top down, national ecosystem management frameworks could support Green Economy goals. For example, India's 2006 National Rural Employment Guarantee Act, invests in the preservation and restoration of ecosystem services which are critical to the livelihoods and economic goals of the rural poor (UNEP, 2011b). For bottom-up strategies, policies and institutions that delegate management responsibilities to local communities may support economic growth and ecosystem protection. The Inpang Carbon Bank project in Northeast Thailand is a good example of providing farmers with access to global carbon markets that also leads to ecosystem protection (Samek et al., 2011). Again, in the GMS, government support is needed for these goals to be achieved.

Examples of Ecosystems Management Supporting a Green Economy in the GMS

Identifying best ecosystem management practices and scaling these up are critical in the transition to a Green Economy in the GMS. Given the breadth of organizational activities already underway, there are many projects to illustrate how the ecosystem approach can be used to support ecosystems, services, and livelihoods. Below, we offer a few specific examples.

Mangrove Restoration in Vietnam

Intensive agriculture and its expansion in the Mekong Delta have rendered increasing proportions of the area to become unsuitable for cultivation (Smith and Maltby, 2003). This is worst in Vietnam where salinity intrusion in the dry season has increased (Erwin, 2009). Climate change amplifies the situation as more flooding in the delta is predicted. In this context, an ecosystem approach could help people better manage agriculture while also adapting to a changing climate. Recently, in Vietnam, over US\$1.1 million was invested in restoring 12,000 hectares of mangroves, which not only increased the resilience of the communities but also saved US\$7.3 million in dike maintenance and led to significant economic benefits for local communities (Reid and Huq, 2005).

National Parks in Yunnan

China has a large protected area system but it suffers from poor management. Some ecosystems have degraded and local people do not often share the benefits of commercial development of reserves. But since 2007, the Yunnan provincial government has experimented with designating national parks using a new framework that includes better ecosystem protection standards and sends more economic rewards to local people (Zhou and Grumbine, 2011). Some ecosystem management principles have been used to construct the new system including more effective monitoring of reserve resources and greater participation by local people. The number of pilot parks is being scaled up out to 2020. If deemed successful, the central government may expand the new parks model to the rest of China.

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Rangeland Conservation for Carbon Sequestration and Local Economic Benefits on the Tibetan Plateau

On the Tibetan Plateau in the headwaters of the Mekong River, a pilot project is underway to simultaneously address grassland restoration, carbon sequestration, and poverty alleviation (Langford 2011). Supported by the UN Food and Agricultural Organization and central and provincial levels of the Chinese government, the pilot connects specific economic incentives to reduced livestock numbers with increasing carbon sequestration on restored rangelands. Much of the monetary benefit will go to local people. The programme combines voluntary participation with government support and is a model for top -down, bottom-up management. In addition, given the location of the project, critical upstream-downstream issues are being addressed which may lead to more integration between headwaters and lower river management.

Biodiversity Conservation Corridors

Launched in 2005 with support from all GMS countries, the Asian Development Bank and the United Nations Environment Programme, the Biodiversity Conservation Corridors Initiative has established several pilot linkages between protected areas to restore ecological connectivity as well as improve human livelihoods in and around the corridors (ADB, 2008). Given the rate of economic development in the GMS, some of the corridors have been impacted by dams, logging, plantation agriculture, mining and habitat fragmentation. But the initiative remains critical to the future of biodiversity in the GMS as it is the only one that addresses the relationship between protected areas and landscape matrix issues in between reserves. The corridors are funded through 2016 when an overall evaluation will occur.

REDD+

Reducing Emissions from Deforestation and Forest Degradation and conservation, sustainable management of forests and enhancement of forest carbon stocks (REDD+) has emerged as a policy instrument with the potential to encourage conservation of forest resources in developing countries (UN-REDD, 2011). REDD+ compensates countries monetarily for protecting ecosystem services (i.e. carbon sequestration, clean water) of forests. The programme also supports co-benefits which accrue as a result of these projects. For example, REDD+ ensures that the rights of local communities are respected and their efforts in conservation are rewarded (UN-REDD, 2010). In the GMS where countries have a wealth of untouched forests, REDD+ provides an opportunity to maintain the structural integrity of ecosystems, while gaining much needed financing for development and enhancing the welfare of forest-dependent communities. The GMS countries have been extremely proactive in REDD+. Viet Nam and Cambodia were both early members of the UN-REDD programme, and Lao PDR has recently begun revising its forestry framework to enable new REDD+ projects (Forest Carbon Asia, 2011).

Recommendations for Using Ecosystem Management in the GMS

For stakeholders in the GMS to adopt an integrated ecosystems approach, what is needed is a re-examination of the subregion's national and societal institutions. We identify five requirements to encourage this process.

1. Develop a strong network between GMS scientific institutions, to support collaborative research. Baseline understanding of ecosystem structure, function and how to monitor changes over time should be primary research goals (Xu and Grumbine, In press). The development of this network can build upon existing ecosystem monitoring programmes and bilateral and multilateral research agreements. How to create effective communication channels between scientists and policy makers should also be considered.
2. Governments in the GMS need to review existing laws, policies and regulations to lay the foundation for an ecosystem management approach. While existing laws may contain fragments of ecosystem management concepts, these are not yet mainstreamed into national environmental policy. Ecosystems are generally not considered a priority and most GMS governments separate natural resource management from economic development. These are difficult issues to address so it would be best to create pilot ecosystem-based programmes within individual ministries and organizations to gather experience before proceeding to full implementation.
3. Legislative reforms should address overlapping jurisdictions, fragmentation of authority and conflicting sectoral objectives which impede efforts to adopt an ecosystem approach. One place to begin would be a country-by country analysis of state environmental impact assessments so that gaps between countries could be identified. Recognizing that it can be difficult to place economic values on ecosystems function, the costs of both adopting and not adopting an ecosystem approach needs to be more clearly defined. Ultimately, there is the need to clarify the relationship between economic growth and ecosystem sustainability in the GMS.
4. Legislative reforms may lead to building a new upstream-downstream institutional framework for managing ecosystems across jurisdictions in the GMS. It is rare to find an ecosystem wholly contained within a single state boundary. The multiple scales of ecosystem management require cooperation among a broad range of state interests as well as improved inter-organizational coordination. Cooperative approaches to management that cut across jurisdictional boundaries must be designed in from the beginning since few exist today. This will be a long-term goal in the GMS and will help to bridge gaps between science and policy-making.
5. In order to translate the above recommendations into action, political commitment at the highest levels is imperative. Without such commitment, the applicability of these recommendations is limited. Leaders in the GMS must learn to recognize the critical role which ecosystems play in maintaining the economic and social stability within their respective countries and the subregion as a whole.

Leaders in the GMS must learn to recognize the critical role which ecosystems play in maintaining the economic and social stability within their respective countries and the subregion as a whole.

Growing climate impacts must also be addressed yet this cannot be done using past approaches.

Conclusion

Ecosystem management is an essential part of the 'tool kit' for sustaining ecosystems and the services they provide. But making progress towards long-term economic development, and tackling climate change in the GMS will not be easy. On one hand, countries are faced with multiple challenges as there is the urgent need to develop national economies while maintaining social stability and environmental sustainability. Growing climate impacts must also be addressed yet this cannot be done using past approaches. On the other hand, ecosystem management approaches will eventually have to be integrated across state boundaries. Using a framework based on the ecosystem approach, climate regulating capacity and protecting ecosystem services, countries can make necessary adjustments in a transition towards a green low carbon economy.

References

- ADB 2005. Connecting Nations, Linking People. Manila: Greater Mekong Subregion Economic Cooperation Program
- ADB 2008. Biodiversity conservation corridors initiative. Pilot site implementation status report 2007. Bangkok: Asian Development Bank Core Environment Program, Greater Mekong Subregion.
- ADB 2009. Biodiversity, Food Security, Water Resources and Rural Livelihoods in the GMS. Manila: Asian Development Bank.
- AHMED, M. & HIRSCH, P. 2000. Common property in the Mekong: Issues of sustainability and subsistence. Penang: The WorldFish Center.
- ARTHUR, R., FRIEND, R. & DUBOIS, M. 2011. Fisheries, nutrition and regional development pathways: Reasserting food rights. In: LAZARUS, K., BADENOCH, N., DAO, N. & RESURRECCION, B. (eds.) *Water rights and social justice in the Mekong region*. London: Earthscan.
- CAO, M., H, H. & LI, L. 2001. Biodiversity Management and Sustainable Development: Lancang-Mekong River in the New Millenium. *International Symposium on Biodiversity Management and Sustainable Development in the Lancang-Mekong River Basin*. Chinese Academy of Sciences.
- DE GROOT, R. S., WILSON, M. A. & BOUMANS, R. M. J. 2002. A typology for the classification, description and valuation of ecosystem functions, goods and services. *Ecological Economics*, 41, 393-408.
- DOSCH, J. 2010. Balancing Trade Growth and Environmental Protection in ASEAN: Environmental issues in Trade and Investment Policy Deliberations in the Mekong subregion. *Series on Trade and the Environment in ASEAN*. Manitoba: International Institute for Sustainable Developmen.
- EASTHAM, J., MPELASOKA, F., MAINUDDIN, M., TICEHURST, C., DYCE, P., HODGSON, G., ALLI, R. & KIRBY, M. 2008. Mekong River Basin Water Resources Assessment: Impacts of Climate Change CSIRO: Water for a Healthy Country National Research Flagship.
- ERWIN, K. 2009. Wetlands and global climate change: the role of wetland restoration in a changing world. *Wetlands Ecology and Management*, 17, 71-84.
- FAO 2010. Asia-Pacific Forests and Forestry to 2020. Bangkok: Food and Agriculture Organization.
- FOREST CARBON ASIA. 2011. *National Workshop: Revising the forestry legal framework to enable effective REDD+ implementation in Lao PDR* [Online]. Vientiane: Forest Carbon Asia. Available: <http://www.forestcarbonasia.org/events/national-workshop-revising-the-forestry-legal-framework-to-enable-effective-redd-implementation-in-lao-pdr/> [Accessed 14 December 2011].
- GAO, Y. & TUO, Y. 2011. HDD prices rise with floodwaters. *China Daily*.
- GMS-EOC. 2011. *The Greater Mekong Subregion: Greater Connectivity and Competitiveness - More Challenges* [Online]. Bangkok: Greater Mekong Subregion-Environment Operations Centre. Available: <http://www.gms-eoc.org/index.php/gms.html> [Accessed 19 December 2011].
- GOH, E. 2004. China in the Mekong River basin : the regional security implications of resource development on the Lancang Jiang. Nanyang Technological University.
- GRUMBINE, R. 1994. What is Ecosystem Management? . *Conservation Biology* 8, 27-38.
- GRUMBINE, R., DORE, J. & XU, J..2012. Mekong Hydropower : Drivers and Governance Challenges. *Frontiers in Ecology and the Environment*. doi:10.1890/110146.

IMF 2010. World Economic Outlook Database. International Monetary Fund, October 2010, Washington D.C.

IUCN. 2011. *Ecosystem Management* [Online]. Gland: IUCN. Available: http://www.iucn.org/about/union/commissions/cem/cem_work/ [Accessed 13 December 2011].

JOHNSTON, R., HOANH, C. T., LACOMBE, G., NOBLE, A., SMAKHTIN, V., SUHARDIMAN, D., PHENG, K. S. & SZE, C. P. 2010. Rethinking Agriculture in the Greater Mekong Subregion. International Water Management Institute (IWMI)

LANGFORD, K. 2011. Harnessing the mitigation potential of soil carbon. Agroforestry World. World Agroforestry Centre (ICRAF), Nairobi.

LAWTON, J. 2011. Long After the Floods Recede, Supply Chains Feel the Pain. *Forbes*.

LAYZER, J. 2008. *Natural Experiments. Ecosystem-based Management and the Environment*, Cambridge, MIT Press.

M-POWER. 2011. *About M-POWER* [Online]. Vientiane: M-POWER. Available: http://www.mpowernetwork.org/About_Us/Overview/index.html [Accessed 13 December 2011].

MA 2005. Ecosystems and Human Well-being: Synthesis. *Millenium Ecosystem Assessment*. Washington DC: World Resources Institute.

MAINUDDIN, M., HOANH, C. T., JIRAYOOT, K., HALLS, A. S., KIRBY, M., LACOMBE, G. & SRINETR, V. 2010. Adaptation options to reduce the vulnerability of Mekong water resources, food security and the environment to impacts of development and climate change. CSIRO: Water for a Healthy Country National Research Flagship.

MRC. 2011. *The Mekong River Commission (MRC)* [Online]. Vientiane: Mekong River Commission. Available: http://www.mrcmekong.org/about_mrc.htm#MRC [Accessed 8 September 2011].

NAM, S. & BUNTHANG, T. 2011. FISHERIES RESOURCES IN CAMBODIA: IMPLICATIONS FOR FOOD SECURITY, HUMAN NUTRITION AND CONSERVATION. *International Conference on Asian Food Security (ICAFS 2011)*. Singapore.

QIU, J. 2010. China drought highlights future climate threats. *Nature*, 463, 142-143.

REID, H. & HUQ, S. 2005. Climate Change – Biodiversity and livelihood impacts. In: ROBLEDO, C., KANNINEN, M. & PEDRONI, L. (eds.) *Tropical forests and adaptation to climate change: In search of synergies*. Jakarta: Center for International Forestry Research (CIFOR).

RERKASEM, B. 2011. *Climate Change and GMS Agriculture*, Chiang Mai, Chiang Mai University Press.

RFD. 2011. *Mekong Region Futures* [Online]. Research for Development Alliance. Available: http://www.rfdalliance.com.au/site/c_proj_one.php [Accessed 13 December 2011].

SAMEK, J. H., SKOLE, D. L., KLINHOM, U., BUTTSEP, C., NAVANUGRAHA, C., UTTARUK, P. & LAOSUWAN, T. 2011. Inpang Carbon Bank in Northeast Thailand: A Community Effort in Carbon Trading from Agroforestry Projects

Carbon Sequestration Potential of Agroforestry Systems. In: KUMAR, B. M. & NAIR, P. K. R. (eds.). Springer Netherlands.

SHAW, R. 2006. Community-based climate change adaptation in Vietnam: inter-linkages of environment, disaster, and human security. In: SONAK, S. (ed.) *Multiple Dimension of Global Environmental Changes*. New Delhi: The Energy and Resources Institute (TERI).

SIDA. 2011. *Shared knowledge provides better Climate Change adaptation* [Online]. Bangkok:

SIDA. Available: <http://www.sida.se/English/Countries-and-regions/Asia/Regional-cooperation-in-Asia/Programmes-and-projects1/Shared-knowledge-provides-better-Climate-Change-adaptation-/> [Accessed 13 December 2011].

SMITH, R. D. & MALTBY, E. 2003. Using the Ecosystem Approach to implement the CBD: A global synthesis report drawing lessons from three regional pathfinder workshops. Montreal: Convention on Biological Diversity.

SUMERNET. 2011. *Insight into Policy: Sumernet Phase 2: Programme Summary* [Online]. Bangkok: Sumernet. Available: http://sumernet.org/index.php?option=com_content&view=section&layout=blog&id=1&Itemid=16 [Accessed 13 December 2011].

THUAN, N. T. H. (ed.) 2011. *Adaptation to climate change in rice production in Vietnam Mekong River Delta*, Chiang Mai: Chiang Mai University Press.

UN-DESA. 2011. *List of Least Developed Countries* [Online]. New York: Development Policy Analysis Division, UN-DESA. Available: http://www.un.org/en/development/desa/policy/cdp/ldc/ldc_list.pdf [Accessed August 18 2011].

UN-REDD 2010. Beyond Carbon: Ecosystem-based benefits of REDD+. In: COUNTRIES, T. U. N. C. I. O. R. E. F. D. A. F. D. R. I. D. (ed.). Rome: UN-REDD.

UN-REDD. 2011. *About REDD+* [Online]. Rome: The United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries. Available: <http://un-redd.org/AboutREDD/tabid/582/Default.aspx> [Accessed 14 December 2011].

UNEP 2009. The Role of Ecosystem Management in Climate Change Adaptation and Disaster Risk Reduction. In: MUNANG, R., LIU, J. & THIAW, I. (eds.). Nairobi: United Nations Environment Programme.

UNEP 2011a. Restoring the natural foundation to sustain a Green Economy: A century-long journey for Ecosystem Management. Nairobi: United Nations Environment Programme.

UNEP 2011b. Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication - A Synthesis for Policy Makers. Paris: United Nations Environment Programme.

WB 2007. Strategy Note on World Bank Regional Support for the Greater Mekong Sub-Region. In: SOUTHEAST ASIA COUNTRY MANAGEMENT UNIT, E. A. A. P. R. (ed.). The World Bank.

WWF 2009. THE GREATER MEKONG AND CLIMATE CHANGE: Biodiversity, Ecosystem Services and Development at Risk. Bangkok: WWF.

XU, J. & GRUMBINE, R. E. In press. Tracking landscape transformation through the use of ecological and socioeconomic indicators in Xishuangbanna, Southwest China, Mekong Region. *Ecological Indicators*.

XU, J. C., GRUMBINE, R. E., SHRESTHA, A., ERIKSSON, M., YANG, X., WANG, Y. & WILKES, A. 2009. The Melting Himalayas: Cascading effects of climate change on water, biodiversity and livelihoods. *Conservation Biology*, 23, 520-530.

YU H, E. LUEDELING & JC. XU 2010. Winter and spring warming result in delayed spring phenology on the Tibetan Plateau. *Proceedings of National Academy of Science, USA (PNAS)*, 107, 22151-56.

ZHOU, D. Q. & GRUMBINE, E. R. 2011. National parks in China: Experiments with protecting nature and human livelihoods in Yunnan province, Peoples' Republic of China (PRC). *Biological Conservation*, 144, 1314-1321







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