SERVIR-Mekong

A Needs Assessment of Geospatial Data and Technologies in the Lower Mekong Region

August 2015

Please cite this document as follows:

SERVIR-Mekong. 2015. A Needs Assessment of Geospatial Data and Technologies in the Lower Mekong Region. ADPC, Bangkok.

Authors and reviewers: Gabrielle Iglesias, Peter Cutter, Brett Shields, Buddhadasa Weerasinghe, David Ganz, Peeranan Towashiraporn, Sean Austin, and Sheena Agarwal

Text editing: Robert Oliver

Front cover image: Anton Balazh / Shutterstock.com

© 2015 SERVIR-Mekong. All rights reserved.

DISCLAIMER

The authors' views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government.

Acknowledgements

We would like to thank the following individuals for their valuable inputs and/or review. Without inputs from these experienced and knowledgeable experts, this assessment would not have been possible. (A list of institutions represented by contributors is included in Appendix D.)

Adalbert Eberhardt, Alan Brooks, Alexander Minett, An Quang Hung, Andrew Nelson, Anna Law, Anne Chaponniere, Anupam Bhatia, Aphone Viengkhamhak, Atthanat Khurat, Aung Nandar Tun, Baek Sook Hee, Barry Flaming, Bastiaan Teune, Benoit Gerfault, Berry Mulligan, Bhushan Shrestha, Bou Vorsak, Brad Arsenault, Brian Kelly, Bui Quang Thanh, Bui Viet Thien, Bun Serey , Chanin Umponstira, Charatdao Kongmuang , Chea Eliyan, Cherdchai Nakthipphawan, Chinorost Boonjerm, Chit Min Tun, Cholticha Niwaspragrit, Chu Thi Thu Ha, Chusit Apirumanekul, Curtis Hundley, Dan Bishton, Dan Constable, Dang Quang Minh, Dang Uloaj Minh, Dao Minh Truong, David Boisson, David Nicholson, Doan Ngoc Pha, Dork Vuthy, Elodie Maria-Dube, Eric Kemp-Benedict, Etienne Delattre, Ha Cao Luan, Ha Chenda, Ha Thanh Lan, Ha Thi Lan Anh, Hanna Helsinger, Helen Cho, Herve Gazeau, Hla Hla Aung, Hoang Quang Huy, Hou Taing Eng, Huon Thavrak, Huong Senthan, Ian Thomas, Ian Wilderspin, Jeff Silverman, Jenty Kirsch-wood, Jessica Chaix, Joan Bastide, Joe Mascaro, Johannes Kaltenbach, John Marinos, Jonathan Shaw, K. M. Win, Kanoksri Sarinnapakron, Kata Kiatmanoj, Kativich Kantha, Kaung Myaf Bo, Keran Wang, Khaled Mashfiq, Khamkeng Chanthavongsa, Khamlor Phonsavat, Khamseng Homdovangxay, Khuat Dang Long, Kim Soben, Kim Vanly, Kong Udom, Ky Quang Vinh, Kyaw Zaya Htun, Lai Duy Son, Lal Samarakoon, Lan Huong Tran, Lan Nguyen Thi Ngoc, Le Nhu Nga, Le Phuoc Thanh, Le Van Duong, Lee Baker, Ly Thi Han, Man Quang Huy, Manish Tewani, Mao Hak, Matthew Maltby, Mayrong Sayathan, Meas Sotheavy, Mevn Channa, Micah Ingalls, Mitsunori Odagiri, Myat Lynn Thuy, Myint Myint Khaing , Myint Myint Kyu, Naruepon Sukumasavin, Nattapon Mahavik, Nattapon Mahavik, Nelson Gapare, Nga Dang, Ngo Ngoc Hung, Nguyen Duy Khang, Nguyen Hanh Quyen, Nguyen Hay, Nguyen Hoang Anh Dung, Nguyen Hong Ninh, Nguyen Huong Thuy Phan, Nguyen Kim Loi, Nguyen Ngoc Thuy, Nguyen Thanh Long, Nguyen Thi Thanh Thuy, Nguyen Thuy Binh, Nguyen Tien Giang, Nguyen Trung Viet, Nguyen Truong Thanh, Nguyen Viet Hung, Nguyen Xuan Dang, Nhem Vannayouth, Nicole Jungermann, Nitin Kumar Tripathi, Nwe Oo Khin, Oo Was Nan, Ouk Makara, Oum Ryna, Pak Sinnara, Palamy Changleuxai, Peraya Tantianuparp, Phaloeun Koy, Pham Anh Tuan, Pham Minh Than, Pham Thanh An, Pham The Vinh, Pham Van Thuong, Phan Anh Tuan, Phaypaseuth Oudomekham, Phien Sayon, Phisut Apichayakul, Phuvasa Chanonmuang, Ponh Sachak, Prak Tav Amida, Prasong Thammapala, Preesan Rakwatin, Quyen Nguyen, Raphael Glemet, Rattamanee Laohapensang, Rebecca Zorn, Ross Sinclair, Royboon Rassameethes, Sai Phong Kham, Sao Sopheap, Sarah Brook, Sarintip Tantanee, Saw Min Htoo, Se Bunleng, Seng Sothira, Shannon Dugan, Sim Sokhema, Siriruk Preukpitikul, So Sovanna, Soim Monichoth, Sok Pheak, Somkith Boulidam, Somvath, Sorn Serey, Sothira Seng, Sovann C. Pheaktra, Steward Motta, Suriya Sassanarakkit, Taksin Archawakorn, Teoh Shwu Jiau, Teresa Leonardo, Terry Parnell, Thavrak, Thiri Dawei Aung, To Thi Minh Trang, Tonh Sachak, Tram Kim Chau, Tran Hoang Yen, Tran Huy Thai, Tran Kim Chan, Tran Thi Quynh Chi, Trinh Thi Long, Truong Ngoc Phuong, Tuan Quoc Vo, Tung Pho Thanh, Van Pham Dang Tri, Vareeporn Jaikriangkrai, Veerachai Tanpipat, Vilakone Kasioudom, Vilon Viphongxay, Vo Khac Tri, Vo Quang Minh, Vo Quoc Tuan, Vu Anh Tuan, Vu Tien Dien, Vu Van Chat, William Francis, Yav Net, Yumiko Kura, Yuttaphum Pothiraja, Zaw Naing.

About SERVIR-Mekong

To enhance and build capacity in the use of geospatial data and analysis in the region, the United States Agency for International Development's Regional Development Mission for Asia (RDMA) awarded a five-year Cooperative Agreement to establish SERVIR-Mekong, the latest regional hub of the global SERVIR program, which is an initiative of USAID and NASA. SERVIR Mekong is hosted by the Asian Disaster Preparedness Center (ADPC) and supported initially by technical partners Spatial Informatics Group (SIG), Stockholm Environment Institute (SEI), and Deltares.

As a geospatial "data for development" project, the goal of SERVIR-Mekong is to support better outcomes for climate change-related themes in the Lower Mekong Region (LMR) through the increased application of geospatial data and analysis in policy, planning and other decision contexts. In addition to the program's primary focus on climate change adaptation and mitigation, SERVIR-Mekong also serves the related themes of land use and land management (including low emissions land-use planning), disaster risk reduction and response, water security and food security.

To achieve this goal, SERVIR-Mekong arranges its work around the following four themes:

1. Building and institutionalizing technical capacity of government decision makers and key civil society groups from the LMR to integrate geospatial information into their decision making, planning, and communication;
2. Improving the sharing of user-tailored geospatial data, products and services;
3. Developing new high quality user-tailored data, tools, applications, and models to address on-the-ground priorities;
4. Ensuring the long-term sustainability of SERVIR-Mekong.

Executive Summary

Rapid economic and population growth in the Lower Mekong Region (LMR) – comprising Cambodia, the Lao People's Democratic Republic, Myanmar, Thailand and Vietnam – continue to drive changes in the region's water regimes as well as the loss and degradation of natural vegetation and soils. These changes, in turn, are having impacts, often negatively, on ecosystem services, food and water security, and biodiversity. All of these impacts are exacerbated by climate change, further highlighting the need for improved governance and decision making in virtually all sectors.

Geospatial data and technology can contribute significantly to more timely and informed decision making. For example, satellite radar-estimated rainfall can extend the early warning period for serious floods. However, in order to be useful in a given planning, policy or other decision making context, information must reach the right people and institutions at the right time and in the right form.

SERVIR-Mekong, the latest addition to a USAID and NASA-initiated global network of hubs supporting the application of geospatial data and technologies for decision making, carried out a needs assessment in late 2014 and early 2015 to inform the program's strategic focus as well as provide a resource for other stakeholders seeking to improve the effective application of geospatial data and technologies in the LMR. This report is the result of that assessment.

Data for the assessment were compiled using three methods: stakeholder consultations, an online questionnaire, and a desk review of relevant literature. A full range of country and regional stakeholders were targeted at the regional and country levels: (a) government agencies, (b) academic and research institutions, (c) non-governmental organizations (NGOs) and other civil society organizations, (d) multi- and bilateral aid agencies, (e) United Nations agencies and similar extra-national governance and support institutions, (f) private sector entities, and (g) individual citizens.

The specific objectives of the assessment were to identify geospatial data and technology needs in the following thematic areas:

- **Key themes** about which geospatial information is considered important for decision making (e.g., land governance and management, water governance and management, climate change adaptation, disaster risk assessment etc.);
- **Geospatial data** (e.g., Landsat remote sensing products, land cover maps, flood forecast maps etc.);
- **Data sharing** (e.g., the sharing of data from public agencies with the public, sharing of data between agencies, standards for metadata and data quality to facilitate sharing etc.);
- **Capacity building** (e.g., basic GIS skills, managing complex server structures etc.); and
- **Tools and applications** (e.g., decision support tools, online information portals, custom desktop applications etc.).

Secondary objectives included identifying: (a) the most promising frameworks and specific strategies for addressing needs; and (b) challenges and solutions related to gender in the development and application of geospatial data and technologies.

Priority **thematic areas,** where stakeholders reported that geospatial data and technologies are playing (or potentially play) a key role, include land use and land cover mapping and monitoring

(especially forests and agriculture); disaster risk management (especially early warning systems for droughts and flooding); water resource planning, management, and monitoring; agricultural monitoring and food security; and climate change adaptation and mitigation.

Priority **data and metadata needs** indicated by stakeholders include: (a) compiling inventories of existing geospatial data products, including metadata related to existing datasets; and (b) facilitating improved policies and practices related to accuracy assessments of geospatial data products. At a more specific level, needed geospatial datasets include land use and land cover patterns and trends, basic infrastructure (especially in Myanmar and the Lao PDR), hydro-meteorological data and forecasts (especially related to rainfall), hazard risk maps, and distribution of natural capital and ecosystem services.

Areas where **data-sharing and/or standards** need the most improvement include generally improving sharing between government agencies as well as between government and non-governmental organizations. Generally increasing the availability of geospatial data via the adoption of open data policies was also identified as a top priority.

Specific challenges cited by stakeholders include: limited opportunities for data users to provide specific feedback to producers (resulting in important issues not being addressed and potentially propagating in multiple data products) and limited use of data shared with government agencies by non-government entities due to a perceived lack of credibility in data collection or processing methods. Improvements in meta-data standards and stewardship are seen as being valuable steps in rectifying these and other issues.

Capacity building priorities identified by stakeholders include: improving basic map, model, and other data interpretation skills within government agencies (especially at sub-provincial levels): and the need for appropriate hardware and budgets to carry out needed geospatial functions. Stakeholders suggested that placing greater emphasis on “on-the- job” training, increasing structured training at universities in the region, improving the retention rate of technical practitioners in public institutions, and improving the availability of local language training materials would all be important for boosting geospatial skills and capacity.

Finally, stakeholder-identified priorities for developing **custom tools and applications** included: (a) mapping and monitoring land use and land cover (especially natural forests, plantation forests, and crops); (b) monitoring and forecasting floods and droughts; ecosystem services; forecasting crop yields; and facilitating basin-wide planning.

Recommendations

Based on the above results and suggestions from stakeholders, the following are recommendations for institutions and projects working to improve the application of geospatial data and technologies for decision making in the LMR:

1. Promote and support the development of a community of practice around the use of geospatial data for decision making.
2. Create web-based resources and support events that bring practitioners together to share experiences and information, coordinate and collaborate on strategies and tools, as well as to build capacity for effectively and efficiently addressing priority needs.
3. Work with decision makers, technical staff, and other stakeholders to develop customized, context-specific decision-support tools that will be used to enhance priority management, planning, and policy development processes.

4. Promote the integration of geospatial considerations across sectors to address issues of contradictory plans, policies and decisions.
5. Develop a guidance note on for GIS developers and application users on how to integrate gender concerns, and point to types and sources of gender-related data that can be used in various GIS tools.
6. Support existing initiatives to clarify, inventory, and harmonize geospatial data resources in all LMR countries, especially in Cambodia, the Lao PDR and Myanmar.
7. Support the further development of a regional network of universities conducting geospatial-related research and capacity building, and support their efforts to more effectively understand and link their work with government agencies.
8. Create and enhance online portals and other data-sharing mechanisms that make it easier for practitioners to access and use satellite-derived data for monitoring and forecasting.
9. Promote international metadata standards and tools that facilitate the efficient authoring and stewardship of metadata.
10. Document the value of open data policies, and showcase examples of how such policies can enhance outcomes and save resources in the region.
11. Work with stakeholders to design, build and maintain decision-support tools related to the region's top geospatial application priorities. These include, in order of priority expressed by contributors to this assessment:
    - Land cover land use monitoring;
    - Flood and drought forecasting and risk mapping;
    - Multi-hazard risk assessment;
    - Water resource monitoring and management;
    - Crop monitoring and food security;
    - Weather monitoring and forecasting;
    - Ecosystem and ecosystem services assessment and monitoring;
    - Environmental impact assessment;
    - Disaster risk management related to extreme weather events, forest fires and landslides;
    - Sea level rise and coastal resource management;
    - Air, soil, and water contaminant monitoring; and
    - Solids/sediment transport in rivers.
12. Using similar methods as those used in this assessment, reassess regional geospatial data and technology needs at two- or three-year intervals so that changing priorities can be identified, and effectively and efficiently addressed.

Contents

List of Tables

List of Acronyms

ADPC	Asian Disaster Preparedness Center
AFOLU	Agriculture Forestry and Other Land Use
CSOs	Civil Society Organizations
FAO	Food and Agriculture Organization
GEOSS	Global Earth Observation System of Systems
GHG	Greenhouse Gas
GIS	Geographic Information Systems
GMS	Great Mekong Subregion
GPM	Global Precipitation Mission
GPS	Global Positioning System
JAXA	Japan Aerospace Exploration Agency
Lao PDR	Lao People's Democratic Republic
LEAF	USAID's Lowering Emissions in Asia's Forests project
LMR	Lower Mekong Region
MIMU	Myanmar Information Management Unit
NASA	U.S. National Aeronautics and Space Administration
NGOs	Non-government organizations
RDMA	Regional Development Mission for Asia
RS	Remote Sensing
USAID	United States Agency for International Development
USFS	United States Forest Service

1. Introduction

1.1. Background and Context

The Lower Mekong Region (LMR), which comprises Cambodia, the Lao PDR, Myanmar, Thailand and Vietnam, faces significant challenges associated with rapid economic, social and environmental changes in recent decades. Many of these challenges are exacerbated by climate change.

Major environmental changes such as alterations to water regimes and the loss or degradation of natural forests are linked to challenges in maintaining ecosystem services, conserving biodiversity, and maintaining soil and soil quality. All of these challenges highlight the need for improved governance and decision making to ensure better outcomes across all three aspects of triple bottom line accounting – economic, social and environmental.

Geospatial data (such as that collected by a growing number of satellite-borne instruments) and geospatial analyses (such as forest change detection) can contribute significantly to more timely and informed decision making. . However, in order to be useful, such information and technologies must reach the right people and institutions at the right time and in the right form for a given planning, policy, or other decision making context.

This assessment was initiated by the SERVIR-Mekong project to explain the strategic focus of, and the opportunities for the project as well as to provide a resource for others seeking to improve the effective application of geospatial data and technologies in the LMR.

1.2. Objectives

The primary objective of this analysis was to identify and prioritize gaps in the availability and effective application of geospatial data and technologies in the LMR. A secondary objective was to recommend strategies for addressing these gaps.

To meet these objectives, the assessment team drew on three distinct information sources: (a) consultation meetings with stakeholders; (b) an online survey; and (c) a desk review of relevant published reports and other literature. Raw data from these sources were then collated and synthesized to identify, organize and clearly present the major geospatial data and technology needs of LMR countries as well as the region as a whole. Finally, based on stakeholder inputs and relevant literature, specific strategies were identified for addressing these needs.

1.3. Scope and Limitations

The geographic scope of this report is the five LMR countries of Cambodia, Lao PDR, Myanmar, Thailand and Vietnam as well as global and regional stakeholders, institutions, patterns, programs etc. that relate to these five countries. Primary information mechanisms for the assessment reached 300 individuals from more than 130 agencies and institutions – a significant and diverse cross-section of the region's geospatial experts, practitioners and other associated stakeholders. The desk review of relevant literature provided additional context and

perspective for interpreting primary data and, in some cases, a valuable insight into how the state of geospatial data and technologies has changed in recent years.

However, as with any sample, it is likely that the set of stakeholders consulted in the limited time available and those who responded to the online survey is biased in some ways. For example, the assessment team particularly targeted government agencies related to natural resource management, space technologies, climate change adaptation and mitigation, and disaster management. There were likely similar (but not fully measureable) biases in the population of individuals who were asked to respond to the online survey.

Another general challenge in assessing and prioritizing needs is that even with a perfect sample of stakeholders, their perspectives on needs will likely differ somewhat from actual needs. For example, it is unrealistic for stakeholders to accurately identify needs if they are not completely aware of what data, capacity and tools are currently available.

More directly, issues related to strategy and protocol of the assessment's sponsor, USAID, prevented the survey team from conducting consultations with government agencies in Myanmar and the Lao PDR. While part of this gap in the sample of respondents was certainly mitigated by other sources of information for these countries, the assessment team is hopeful that follow-up efforts may include these direct consultations.

Fortunately, and by design, the overall approach of this assessment lends itself to periodic updating and the reporting team envisions that such efforts will be undertaken to: (a) further minimize sample bias, and (b) reflect actual changes in perceptions of priority gaps in geospatial data and technology in the LMR so that limited resources may be directed in the most strategic and effective way – resulting in better decision making as well as better outcomes for the people and ecosystems of the region.

2. Methods

Data for the assessment were compiled from three distinct sources:

- **Stakeholder consultations** (e.g., live meetings with stakeholders);
- **An online survey**; and
- **A desk review** of relevant published reports and other literature.

Each of these types of information has its own inherent strengths and weaknesses. The assessment team felt that together, their complementarity and value in corroborating various findings would result in a higher degree of confidence in the assessment's findings. All three information sources provided valuable insights into the needs and current status of the full range of country and regional stakeholders – which can loosely be classified as associated with the following: (a) government agencies; (b) academic and research institutions; (c) NGOs and other civil society organizations; (d) multi- and bilateral aid agencies, United Nations agencies and similar extra-national governance and support institutions; (e) private sector entities; and (f) individual citizens.

The SERVIR-Mekong needs assessment team with officials from the Cambodia Ministry of Water Resources.

As the primary target of this assessment, the ***geospatial data and technology needs*** identified were grouped and presented in terms of the following thematic categories (chapter 3):

- **Key themes** about which geospatial information is considered important for decision making (e.g., land governance and management, water governance and management, climate change adaptation, disaster risk assessment etc.);
- **Geospatial data** (e.g., Landsat remote sensing products, land cover maps, flood forecast maps etc.);
- **Data sharing** (e.g., the sharing of data from public agencies with the public, sharing of data between agencies, standards for metadata and data quality to facilitate sharing etc.);
- **Tools and applications** (e.g., decision support tools, online information portals, custom desktop applications etc.); and
- **Capacity building** (e.g., basic GIS skills, managing complex server structures etc.)

Within each of these categories, findings are presented in sections for each LMR country as well as a section for findings relevant to the LMR as a whole.

The report team drew from all three information sources to identify and prioritize strategic priorities and approaches, and for addressing priority gaps (chapter 4). A brief review of major country and regional initiatives (presented at the end of chapter 3) provided further useful context with regard to identifying priorities and strategies for addressing gaps.

Table 2-1. Summary of the Global Earth Observation System of Systems (GEOSS) thematic framework used by SERVIR-Global.

GEOSS Themes	Scope of GEOSS Theme (from the SERVIR-Global website)
Disasters	Reducing loss of life and property from natural and human-induced disasters.
Ecosystems	Monitoring ecosystem conditions and trends; improving the management and protection of terrestrial, coastal and marine ecosystems.
Water	Improving water resource management through a better understanding of the water cycle.
Climate	Understanding, assessing, predicting, mitigating and adapting to climate variability and change.
Agriculture	Models for simulating and predicting agricultural trends; supporting sustainable agriculture and combating desertification.
Health	Understanding environmental factors affecting human health and well-being.
Weather	Improving weather information, forecasting and warning.
Biodiversity	Understanding, monitoring and conserving biodiversity (distribution and status of species, genetic diversity in key populations; condition and extent of ecosystems).

2.1. Stakeholder Consultations

Stakeholder consultations were conducted in two formats:

- Meetings with targeted government agencies, academic and research institutions, and other institutions; and
- Structured roundtable discussions with primarily non-government stakeholders (including those from academic and research institutions, NGOs and civil society groups, multi- and bilateral aid agencies, United Nations and similar governance bodies, and private sector entities).

At the targeted meetings and the roundtable events, participants were asked to identify:

- Priority thematic areas where geospatial data and/or technologies could enhance decision making;
- Key needs and gaps in terms of specific geospatial datasets;
- Data sharing issues and challenges;
- Capacity needs and gaps with regard to geospatial data, technologies, and application in decision making; and

- Existing initiatives (e.g., projects, decision support tools, online data portals etc.) that are related to any of the above.

2.2. Online Questionnaire

In keeping with the assessment's overall information compilation objectives, an online questionnaire was created that requested the respondents to complete with sections related to their:

- Professional role, institutional affiliation, and GIS and remote sensing background;
- Perspectives on geospatial data and technology needs in terms of key themes, data needs and gaps, data sharing challenges, capacity needs and gaps, decision support tools and applications; and
- Perspectives on gender issues related to the preparation, use and access to geospatial data and technologies.

An invitation to complete the online questionnaire was circulated via e-mail to more than 1,000 potential respondents thought to have valuable perspectives on the above topics. A special effort was made to include stakeholders who could not attend the live stakeholder consultations.

Appendix B provides a complete set of the questions and (where applicable) the response choices that were provided in the online questionnaire.

2.3. Desk Review

To complement primary data from consultations and the online questionnaire, the assessment team identified articles, journals and papers relevant to the objectives of the assessment. Short summaries of resources consulted are provided in Appendix E.

Table 2-2. Strengths and weaknesses of complementary information sources used in this assessment

Data tiers	Pros	Cons
Stakeholder consultations	Targeted participants. Follow-up questions for deeper insight. Facilitator insight can "read between the lines" of what is said.	Facilitator-guided questions may create specific focus on directed outcomes and miss other points of inquiry for the country partners.
Online questionnaire	Can reach large group. Can provide statistical data to assert verbal opinion. Peer-tested viewpoints. Depth of analysis moderately high.	Misinterpretation of questions. Misaligned answer to question. Poor response rates. Not always relevant or well-connected to project targets.
Desktop review	Scientific framing. Peer-tested viewpoints. Depth of analysis moderately high. Can reach large group. Can provide statistical data to assert verbal opinion.	Not always relevant or well-connected to project targets. Misinterpretation of questions. Misaligned answer to question. Poor response rates.

3. Results

More than 300 people representing more than 130 institutions provided information for this assessment via either direct consultations or by responding in detail to the structured online questionnaire. This pool of contributors was diverse in terms of geographic and thematic area of experience and expertise as well as institutional affiliation.

All but one (Cambodia) of the five LMR countries assessed indicated disasters as the top priority for the application of geospatial data and technologies. Cambodia indicated ecosystems as the top priority, with disasters a close second. Altogether, three GEOSS thematic priorities clearly stood out in the region – disasters, ecosystems and water. All other themes, although indicated as lower priorities overall, were indicated as priorities by at least some respondents in some countries.

Contributors from Thailand and Vietnam also identified climate and agriculture-related topics as a significant priority whereas these were both less of a priority for Cambodia, the Lao PDR and Myanmar. The only country that indicated health-related topics also had a significant relative priority was Myanmar.

The following sections provide more detailed information organized by need category and geography.

Table 3-1. Summary table of thematic priorities expressed by consultation and online questionnaire contributors. The values in columns two to seven reflect the percentage of respondents (consultations and online questionnaire results combined), indicating that theme as a top priority for each geography assessed. Column eight shows the combined regional ranking for all GEOSS themes.

GEOSS theme/ subtopic	Vietnam	Cambodia	Myanmar	Lao PDR	Thailand	Lower Mekong Region aggregate	Lower Mekong Region ranking
Disasters	33	30	31	30	39	32	**1**
Ecosystems	27	34	29	29	6	25	**2**
Water	17	15	18	22	26	20	**3**
Climate	10	4	5	3	16	8	**4**
Agriculture	9	4	4	3	10	6	**5**
Health	0	5	10	1	3	4	**6**
Weather	0	7	0	9	0	3	**7**
Biodiversity	0	1	0	1	0	0	**8**
Miscellaneous	3	0	4	2	0	2	

3.1. Detailed Summary of People and Institutions Engaged in this Assessment

Country representation by individual contributors was not even, with Vietnamese contributors representing nearly half of all contributors. Stakeholders from Cambodia, Myanmar and the Lao

PDR represented the next largest pools of contributors (in that order) while Thailand was represented by the fewest contributors. This representation is in no way a reflection of the level of country interest but more the result of disproportionate logistical challenges in involving stakeholders. In the case of Thailand, the mandate of SERVIR-Mekong is to engage with Thailand as a capacity building partner in the region – so relatively less effort was put towards consultations in that country.

The institutional breakdown of respondents was also uneven, with government officials forming the largest pool of respondents, followed by those affiliated with an academic or research institution. Stakeholders affiliated with NGOs and CSOs formed the next biggest pool, with United Nations agencies, multi- and bilateral aid agencies, and private sector stakeholders all having significantly less relative representation. This distribution was mostly due to the institutions that the assessment team sought to target – with the perspectives of government and academic stakeholders seen as particularly valuable in the context of SERVIR-Mekong's mandate.

Results from the online questionnaire indicate that most respondents have significant awareness of, and familiarity with Google Earth, GPS, GIS and remote sensing information processing systems. Although familiarity with geospatial data and technologies was not explicitly assessed in the consultations, it was clear to the assessment team that, for the most part, familiarity with geospatial data and technologies was lower in that pool of respondents.

3.1.1. Stakeholder Consultations

A total of 199 people from 128 distinct agencies, organizations and other institutions contributed information and perspectives in targeted meetings and roundtable discussions during stakeholder consultation trips to Cambodia, Vietnam, Myanmar, Thailand and the Lao PDR between December 2014 and May 2015. The consultations included meetings with representatives from a range of government agencies, academic and research institutions, NGOs and other civil society organizations, multi- and bilateral aid agencies, United Nations agencies and similar extra-national governance and support institutions, private sector entities and individual citizens. Institutions with which contributors are affiliated are listed in Appendix C.

3.1.2. Online questionnaire

The online questionnaire was completed by a total of 55 people (19 women and 34 men). Not all respondents answered every question.

Respondents were asked to identify the country or countries to which their answers and perspectives were relevant. Many respondents indicated that their answers were relevant to multiple countries. In all, 20 responses were relevant to Cambodia, 17 to the Lao PDR, 16 to Myanmar, 18 to Thailand, and 30 to Vietnam.

The summarized results from the completed online questionnaires are presented in Appendix D.

3.1.3. Desk Review

While the timeframe for the desk review precluded an exhaustive literature review, 17 documents were found to be particularly relevant to the scope of the assessment. Some were relevant to one country, others to multiple LMR countries or even larger geographies. These materials provided an important perspective beyond the primary consultation and online questionnaire data.

3.2. Key Themes

3.2.1. Lower Mekong Region

Stakeholders highlighted the following interrelated thematic areas where geospatial data and technologies is seen to be most important in the next several years: (a) disaster management; (b) land cover mapping and monitoring; (c) water management, flood and drought forecasting; and (d) food security. Assigning responses to the standardized GEOSS themes, it is clear that disasters, ecosystems and water-related topics are seen as the top overall priorities in the region.

3.2.2. Myanmar

Key thematic areas where geospatial technologies are seen as playing (or to potentially play) an important role include: (a) land use and land cover monitoring (especially mangrove and dryland forest monitoring); (b) flood forecasting and management; (c) emergency response and disaster management; (d) infrastructure development planning and impact assessment; (e) water resources planning; and (f) air, water and soil pollution mapping.

3.2.3. Lao PDR

Key thematic areas for the use of geospatial data and technologies identified by participants include: (a) land use planning; (b) hydrological and meteorological modelling (especially for integrated water resource management); (c) disaster risk management; (d) modelling/management of sedimentation in the Mekong River; (e) forest monitoring and management; (f) real-time disaster-related mapping; and (g) infrastructure mapping.

3.2.4. Cambodia

Key thematic areas where geospatial technologies are seen as playing (or to potentially play) a key role in Cambodia include: (a) land use planning and monitoring (especially forest monitoring); (b) early warning systems (for drought, flooding, forest fires, landslides and cyclones); (c) water resource management; (d) public health; and e) resources for compiling and reviewing environmental impact assessments.

3.2.5. Vietnam

Key thematic areas where geospatial technologies are seen as playing (or to potentially play) a key role include: (a) land cover mapping and monitoring (especially forests); (b) disaster risk management; (c) water management and monitoring (including flood warning systems together with modelling and measuring the impacts of dams on major rivers); (d) agricultural monitoring; and (e) yield forecasting. The overriding thematic priority area identified by almost all stakeholders in southern Vietnam was the need to better understand, monitor and manage

upstream processes in the Mekong River system and their consequences for the densely populated Mekong Delta cities and Ho Chi Minh City. Other thematic priorities include: (a) changing temperatures, sea levels and rainfall regimes (in particular, the impact that these changes will have on the agriculture sector); and (b) a better understanding of mangrove ecosystems and their value.

3.2.6. Thailand

Thematic areas where geospatial technologies are seen as playing (or to potentially play) a key role in Thailand include: (a) disaster preparedness; (b) ecosystem monitoring; (c) water resource and flood management; and (c) climate change adaptation.

3.3. Data Needs

3.3.1. Lower Mekong Region

General challenges in the area of geospatial data include: (a) basic land cover data products; (b) inconsistent and incomplete metadata; (c) infrequent updates to important country and regional level datasets; and (d) a lack of trust among stakeholders in using each other's data with confidence.

3.3.2. Myanmar

Data gaps identified by stakeholders include: (a) the need for more complete information on basic infrastructure (such as roads, hospitals and schools); (b) consistent and high-quality land cover and land use products (the need for improved application of error assessment and validation techniques was highlighted); (c) spatial information on the distribution of natural capital and related ecosystem services; (d) improved census data; (e) more standardization of place names; and (f) geographically explicit information on risks such as flooding, cyclones and landslides.

3.3.3. Lao PDR

Specific data gaps identified for the Lao PDR include: (a) the lack of detailed data on land use, hazard exposure, and sediment flows (in the Mekong); and (b) limited availability of meteorological data such as rainfall. More generally, stakeholders reported a need for improved accuracy assessment of data products, better metadata standards and practices, and a shift toward open data policies to improve data transparency and access.

3.3.4. Cambodia

Cambodia stakeholders highlighted gaps in data related to land use, the status of ground and surface water, landmines, and river levels/flow rates. Insufficient or non-existent metadata is an issue in virtually all agencies and institutions as is simply good information on what geospatial data is available for what areas (e.g. basic data inventories). Also noted were gaps in tools and applications such as the need for better information and models for forecasting weather and floods and the need for better forest monitoring systems capable of producing near-real time maps.

3.3.5. Vietnam

Data gaps identified by stakeholders include: (a) the need for more consistency in the preparation and stewardship of metadata; and (b) regularity of updates to key geospatial datasets. At the subnational level, it is often difficult to access appropriately downscaled hydro-meteorological data that are needed for forecasting and planning work.

3.3.6. Thailand

Outstanding data gaps in Thailand include land and forest cover maps that are infrequently updated and undergo insufficient ground truthing to estimate accuracy.

3.4. Data Sharing and Standards

3.4.1. Lower Mekong Region

Metadata and data access were consistently identified as two of the key challenges to improving the use of geospatial information in decision making in the region, and stakeholders highlighted the need to be more proactive in engaging communities in the creation of spatial data as well as in ensuring that communities and individuals have increased access to spatial information products and media. Clearer standards in terms of metadata and training of geospatial technologies were both seen as critical areas for investment – especially by the region's academic and research institutions.

3.4.2. Myanmar

Data sharing priorities were seen to include the need for agencies to share data more freely and frequently with each other as well as the need for better access (by both government and non-government entities) to existing data. Data sharing is hampered by slow Internet and poor connectivity in general among government agencies, and between these agencies and the public. Security concerns limit sharing of even basic topological maps–forcing some agencies to hand-digitize data that is already in electronic format in other agencies.

3.4.3. Lao PDR

Lao PDR stakeholders highlighted the need for improved sharing of data (a) between upstream and downstream Mekong countries, (b) between government agencies, and (c) between the research community and decision makers as well as (d) by specific projects funded by NGOs and bi- and multilateral donors. Data provided by countries to the Mekong River Commission is often in different formats and this makes data interoperability a challenge. Increasing the online availability of information is seen as a key to improving overall data sharing and access. Increased local involvement in the collection, validation and management of data is needed to improve data sharing and its effective use.

3.4.4. Cambodia

Areas where data sharing needs to be improved in Cambodia include sharing between government agencies and between NGOs. There is often no channel for feedback from data users to producers, so important issues are not addressed and may continue to propagate in multiple data products. Additionally, data shared with government agencies by non-government entities (e.g., NGOs, academic institutions, development agencies etc.) are often seen as not

credible due to a lack of trust in the methods and supporting documentation. Improvements in metadata generation and stewardship are seen as being valuable steps in rectifying this pattern.

3.4.5. Vietnam

Data sharing gaps that were identified included insufficient sharing of information between government agencies, insufficient mechanisms for disseminating existing information (e.g., disaster-related information), and insufficient flow of data from government agencies to the public. On the regional scale, stakeholders at the roundtable meetings noted the lack of data from China with regard to the management of dams and how this may be having an impact on water and sediment flows in the lower Mekong River. There is a general perception that China is especially "closed" with regard to sharing data that are critical to managing the complex ecosystems and landscapes that make up the delta region.

3.4.6. Thailand

Data sharing has advanced significantly in recent years, with more agencies making key data available to their constituents and, in many cases, the public. However, data sharing policies are uneven among agencies and data sharing is still often achieved via informal personal networks.

3.5. Capacity Gaps

3.5.1. Lower Mekong Region

Regional-level capacity issues include the need to improve the application of research results to development work and planning. Concern was expressed that stakeholders at every level had insufficient examples that illustrated how geospatial data could improve decision making. Stakeholders also expressed an interest in ensuring that gender issues were appropriately addressed in planning contexts using geospatial data and technologies.

3.5.2. Myanmar

Geospatial capacity building priorities identified include: (a) increasing the basic capacity of government employees to understand and utilize spatial data; (b) improvement of the selection of geospatial tools and approaches so that they are appropriate to a given objective; and (c) adjusting capacity building activities to focus more on local users and less on technically-oriented users. Key considerations in addressing these capacity gaps include: (a) adopting more of an "on-the-job" training or "learning-by-doing" approach to capacity building; (b) leveraging the networks and capabilities of Myanmar's existing dedicated training organizations and technical colleges; and (c) ensuring that tools, knowledge products and training resources are translated into the local language where appropriate.

3.5.3. Lao PDR

Geospatial capacity building is needed within several agencies including the Ministry of Environment, which is seen as being a center of geospatial information analysis and dissemination. However, there is a high turnover rate of staff with geospatial skills and experience. Stakeholders suggested that an increased focus on academic institutions and

associated structured curricula would be a key to boosting geospatial skills and capacity. The National Geographic Department was also seen as a key agent in supporting increased capacity to generate, manage and utilize geospatial data.

3.5.4. Cambodia

Capacity building priorities identified for Cambodia include basic map, model and other data interpretation skills within government agencies (especially at the sub-provincial level) as well as the need for appropriate hardware and budgets to carry out needed geospatial functions.

3.5.5. Vietnam

In terms of capacity building, a number of stakeholders, both from government and from non-government institutions, highlighted the need to (a) increase the ability of subnational planning agencies to access and use geospatial data and (b) bridge a perceived gap in the linkage between information and real-world policy and planning processes. Also recommended was improved adherence to best practices when creating data, which is related to an identified need to better understand and apply metadata standards and best practices. Stakeholders from municipal offices in Can Tho and Ho Chi Minh City reported that it was difficult to recruit and retain staff with geospatial analysis and interpretation skills.

3.5.6. Thailand

Several Thai agencies, including the Geo-Informatics and Space Technology Development Agency (GISTDA) and the Hydro and Agro Informatics Institute (HAII), are taking a proactive approach to capacity building, and are investing significant resources in national and regional level training. However, universities in Thailand still see a need for improved linkages between academic and research institutes and government agencies.

3.6. Application (Tool) Needs

Application needs that were expressed both during the consultations and in the online questionnaire closely mirrored country thematic priorities–which were quite consistent across the five LMR countries.

There was overwhelming endorsement regarding the need for consistent, well documented land cover map products at both the country and the regional level. The drivers of this need are diverse, ranging from countries wanting to more effectively meet IPCCC reporting requirements to a growing interest in using high quality land cover base maps for better assessment and calculation of natural capital and ecosystem services. One or more applications are thus needed to: (a) be able to produce consistent, high-quality land cover maps at the regional level on a more frequent basis; and (b) make similar processes easier for technical staff at the country level.

Although disasters ranked highest in terms of priority GEOSS themes, applications needed in this area were less clear-cut than for land cover and some other themes. However, a consistent thread was the need for improved risk assessment (often indicated in a multi-hazard context) and early warning systems. The most frequently cited applications of both such tools included

floods (and general water resource accounting and management), drought, forest fires, landslides and extreme weather events.

Also in relation to the GEOSSS water theme, the need was expressed for basin-wide integrated management tools that can anticipate and therefore lead to better understanding and management of water and soil resources, erosion and sediment transportation. Use of this type of tool is often envisioned in a food and water security context.

Tools related to climate change were often proposed in the context of coastal management, sea-level rise, and increasing salinization of aquifers and soils in coastal and delta areas. These tools are seen as being particularly "data-hungry" by stakeholders.

In the case of agriculture, stakeholders indicated a need for improved rice and other crop-monitoring decision support tools that leverage the coverage of satellite images and, potentially, satellite-derived hydro-meteorological information for estimating yields.

3.7. Major Programs and Projects Actively Working to Address Geospatial Data and Technology Needs in the Lower Mekong Region

In the course of this assessment, the SERVIR-Mekong team met with a range of international institutions that are working to build capacity for, or otherwise facilitate the use of geospatial data and technologies. Several of these are discussed below and should be seen as important for individuals and agencies seeking to improve the application of geospatial data to the region's challenges.

ESCAP Space Applications Programme for Sustainable Development

The United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) geospatial program was launched to promote and coordinate regional space cooperation for development through policy, research and techniques as well as projects of regional interest. The focal area of the program is disaster risk reduction and disaster management.

Within this program, one important initiative is the Regional Cooperative Mechanism for Drought Monitoring and Early Warning, which was created to address the relatively weak capacity of many ESCAP countries to (a) access and analyse critical information, develop effective methodology for combining space-based information with in situ data for appropriate decision making, and (b) coordinate information-sharing among national-level agencies.

(www.unescap.org/our-work/ict-disaster-risk-reduction/space-technologies-and-gis-applications-sustainable-development/about).

United Nations Office for Outer Space Affairs (UNOOSA)

UNOOSA conducts international workshops, training courses and pilot projects on topics that include remote sensing, satellite navigation, satellite meteorology, tele-education and basic space sciences for the benefit of developing nations. Recent UNOOSA-led evens include the East Asia Summit Workshop on Applications of Space Information Technology in Major Natural Disaster Monitoring and Assessment, which was held in China from 2 to 5 June 2015.

(www.unoosa.org/).

United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UNSPIDER)

UNSPIDER is a program that aims to create capacity and access to disaster management data and ensure that countries as well as international and regional organizations have both access and capacity to use all types of space-based information needed to support the full disaster risk management cycle.

(www.un-spider.org/).

UNITAR's Operational Satellite Applications Programme (UNOSAT)

The United Nations Institute for Training and Research (UNOSAT) is a principal training arm of the United Nations providing individuals, governments and organizations with knowledge, skills, and strategy to effectively overcome contemporary global challenges. UNOSAT's training targets two key groups of beneficiaries: (a) the delegates to the United Nations and others who develop intergovernmental agreements establishing global norms, policies, and programmes, and (B) the key national change agents who turn global agreements into action.

(www.unitar.org/unosat/).

Asian Development Bank – Greater Mekong Subregion Core Environment Program (CEP)

The Asian Development Bank (ADB) hosts the Greater Mekong Subregion (GMS) Environment Operations Center (EOC), which provides technical and coordination support for the GMS Core Environmental Program (CEP). This includes the maintenance of an online knowledge hub for a range of geospatial data and products pertaining to environment, economic development (energy and transport) as well as national statistics.

(http://www.gms-eoc.org/GMS-eoc)

Open Development Mekong

Open Development Mekong (ODM) is an open data and information platform that uses geospatial data and map products to track development trends at the national and regional levels. It is an NGO that serves as a joint initiative between the East-West Management Institute's Open Development Initiative and World Resources Institute.

ODM hosts a regional website as well as individual country websites. It is an independent collector and provider of data on development trends related to social, economic and environmental development in the Mekong region.

(https://opendevelopmentmekong.net).

4. Conclusions and Recommendations

4.1. Conclusions

While the needs of countries assessed are diverse in terms of geospatial data and technologies, this assessment points to a number of robust conclusions that may be useful for those working to build capacity at the regional and country level.

Overall, the Lower Mekong Regional can be characterized as being in a state of rapid transition from a generally data-poor region only several years ago, to one in which governments are taking significant steps to improve the ability to create, access, and apply geospatial data and technologies to a wide range of policy, planning, and other decision contexts.

Whereas Laos is still focused on creating important base data layers for forest cover and infrastructure, overall geospatial priorities in Vietnam relate more to improving access to and use of existing data. Given the interconnectedness of the region's complex river systems, all of the Mekong countries are working to increase the quantity and flow of hydro-meteorological information to be able to better manage water resources, maintain the complex and productive ecology of the Mekong and other rivers, and be able to forecast flood events with enough lead time to safeguard the region's growing human population.

4.2. Recommendations: Responding to Regional and Country Needs

Based on the combined results of this assessment, including priority needs and suggestions from stakeholders for addressing those needs, the assessment team recommends the following to individuals, programs and institutions working to improve the application of geospatial data and technologies for decision making in the LMR. Most of the recommendations are relevant to all LMR countries, although a specific geographic focus is indicated for some recommendations.

1. Promote and support the development of a community of practice around the use of geospatial data for decision making.
2. Create web-based resources and support events that bring practitioners together to share experiences and information, coordinate and collaborate on strategies and tools, as well as to build capacity for effectively and efficiently addressing priority needs.
3. Work with decision makers, technical staff, and other stakeholders to develop customized, context-specific decision-support tools that will be used to enhance priority management, planning, and policy development processes.
4. Promote the integration of geospatial considerations across sectors to address issues of contradictory plans, policies and decisions.
5. Develop a guidance note on for GIS developers and application users on how to integrate gender concerns, and point to types and sources of gender-related data that can be used in various GIS tools.
6. Support existing initiatives to clarify, inventory, and harmonize geospatial data resources in all LMR countries, especially in Cambodia, the Lao PDR and Myanmar.

7. Support the further development of a regional network of universities conducting geospatial-related research and capacity building, and support their efforts to more effectively understand and link their work with government agencies.
8. Create and enhance online portals and other data-sharing mechanisms that make it easier for practitioners to access and use satellite-derived data for monitoring and forecasting.
9. Promote international metadata standards and tools that facilitate the efficient authoring and stewardship of metadata.
10. Document the value of open data policies, and showcase examples of how such policies can enhance outcomes and save resources in the region.
11. Work with stakeholders to design, build and maintain decision-support tools related to the region's top geospatial application priorities. These include, in order of priority expressed by contributors to this assessment:
    - Land cover and land use monitoring;
    - Flood and drought forecasting and risk mapping;
    - Multi-hazard risk assessment;
    - Water resource monitoring and management;
    - Crop monitoring and food security;
    - Weather monitoring and forecasting;
    - Ecosystem and ecosystem services assessment and monitoring;
    - Environmental impact assessment;
    - Disaster risk management related to extreme weather events, forest fires and landslides;
    - Sea level rise and coastal resource management;
    - Air, soil, and water contaminant monitoring; and
    - Solids/sediment transport in rivers.
12. Using similar methods as those used in this assessment, reassess regional geospatial data and technology needs at two- or three-year intervals so that changing priorities can be identified, and effectively and efficiently addressed.

Bibliography

AFOLU Working Group. 2014. *Technical Workshop on Integrating Forestry, Wetlands and other Land Use/Land Cover data for Greenhouse Gas Reporting*. Jakarta. Retrieved from http://prod-http-80-800498448.us-east1.elb.amazonaws.com/w/images/4/47/Jakarta_AFOLU-WG_Final_Report.pdf.

Asian Development Bank. 2014. *Space Technology and Geographic Information Systems Applications in ADB Projects*. Manila. Retrieved from www.adb.org/sites/default/files/publication/148901/space-technology-and-gis-applications-adb-projects.pdf.

Bruce, B. and B. Ryerson. 1992. Technology Transfer and Remote Sensing: Models for Success and Models for Failure. In *XVIIth ISPRS Congress,* August 2-14, 1992 (pp. 240-246). Washington, D.C.

Department of Survey and Mapping, Vietnam Ministry of Natural Resources and Environment. 2011. Viet Nam Report on Development of Geospatial Information System. In *First High Level Forum on Global Geospatial Management Information, Seoul, Republic of Korea, 24-26 October 2011*. Hanoi. Retrieved from: https://ggim.un.org/docs/meetings/Forum2011/CRP%20no.%201_Viet%20Nam%20country%20report.pdf.

Eastman, J. and J. Toledano. 1996. GIS Technology Transfer: An Ecological Approach. Final project report.

van de Giesen, N. et al. 2013. Survey of needs for Water and Climate Services in Vietnam. Delft University, Delft, The Netherlands.

Ministry of Environmental Conservation and Forestry, Myanmar, Smithsonian Institution, United States of America, and World Wildlife Fund (2013). *Workshop Report: Geospatial Analysis Training and Strategic Planning Workshop in Myanmar, 17-25 June 2013*. Retrieved from: www.geggmyanmar.org/wp-content/uploads/2014/08/MOECF-SI-WWF-Myanmar-Geospatial-Conservation-Training-WS-Draft-Report-Sept-30-2013.pdf.

Netzer, M. and E. Swails. 2010. Summary of Needs Assessment for Regional Cooperation of LMS Countries for REDD+.

Roessner, J. D. 2000. Technology transfer. In C. Hill, Ed., Science and Technology Policy in the US, a Time of Change. Longman, London. Cited in B. Bozeman, "Technology transfer and public policy: A review of research and theory," Research Policy (29) 2000, pp. 627-655.

Space Studies Board. 2001. "Transforming Remote Sensing Data into Information and Applications".

SEA-CC Net and Adaptation Knowledge Platform. 2011. Desktop Study on Assessment of Capacity Gaps and Needs of South East Asian Countries in Addressing Impacts, Vulnerability and Adaptation to Climate Variability and Climate Change. Retrieved from: www.climateadapt.asia/upload/publications/files/4e1aba053931aDesktop_Study_Vulnerability_&_Adaptation.pdf.

SERVIR Program Demand Activity. 2013. Lower Mekong Geospatial Assessment. Development Alternatives Incorporated. Bangkok.

United Nations Economic and Social Commission for Asia and the Pacific. 2007. Space Technology Application Capabilities, Facilities and Activities in Asia and the Pacific: A Regional Inventory. Retrieved from: www.unescap.org/icste/pubs/st_ESCAP_2463.pdf.

United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER). 2014. Recommendations of the Geospatially Enabling Community Collaboration (GECCo) workshop.

——— 2013. Report of the Technical Advisory Mission to Vietnam.

——— 2012. Report of the Technical Advisory Mission to Myanmar.

U.S. Forest Service. 2011. Climate Change in Vietnam: Assessment of Issues and Options for USAID Funding. Retrieved from: www.usaid.gov/sites/default/files/documents/1861/vietnam_climate_change_final2011.pdf.

USAID Lowering Emissions in Asia's Forests Project. 2011. Rapid Assessment of the Political, Legal and Institutional Setting. Compilation: Cambodia Rapid Assessment; Lao PDR Rapid Assessment Thailand Rapid Assessment and Vietnam Rapid Assessment. Retrieved from: www.leafasia.org/sites/default/files/public/resources/RapidAssessment_Vietnam_Public_Final.pdf.

Wood, D. 2012. Building Technological Capability within Satellite Programs in Developing Countries (Unpublished doctoral dissertation). Massachusetts Institute of Technology, United States.

World Bank and UNISDR. 2013. Strengthening of Hydrometeorological Services in Southeast Asia: Country Assessment Report for Cambodia; Country Assessment Report for the Lao PDR; and Country Assessment Report for Viet Nam. Retrieved from: www.unisdr.org/files/33988_country_assessmentreportvietnam[1].pdf.

Appendices

Appendix A. Sample Consultation Note and Meeting Agenda

SERVIR Mekong Introduction and Stakeholder Consultation

Organized by Asian Disaster Preparedness Center
in Coordination with
USAID RDMA and USAID Cambodia
4 December 2014 ● Cambodiana Hotel, Phnom Penh

Background

The United States Agency for International Development (USAID) and the U.S. National Aeronautics and Space Administration (NASA) recently announced the initiation of SERVIR Mekong, the newest regional hub in the global SERVIR network that will promote the use of satellite imagery to help Asia's Lower Mekong region better predict and cope with natural disasters, increase resilience to climate change, and better understand and value of ecosystem services.

SERVIR Mekong, implemented by the Asian Disaster Preparedness Center (ADPC) and its technical partners Spatial Informatics Group (SIG), Stockholm Environment Institute (SEI), and Deltares, will help governments and other key decision makers in Myanmar (Burma), Cambodia, Lao PDR, Thailand, and Vietnam to take advantage of publicly available satellite imagery, geospatial data, and custom applications to make more informed decisions on issues such as water management, land-use planning, disaster risk reduction, infrastructure development and natural resources management.

More information on SERVIR is available at www.servirglobal.net.

Objectives

- Introduce the SERVIR Mekong Program and implementing consortium
- Identify needs, priorities, and challenges that SERVIR Mekong can address

Anticipated Participants

Representatives from academic and research institutions, NGOs/CSOs, development partners and relevant private sector entities (e.g., technical consultancies, etc.).

Agenda

Time	Activity/Topic
8:30	Introductions
8:45 - 9:45	Introduction to SERVIR Mekong -- presentations by: Dr. Sean Austin, USAID SERVIR Mekong Coordinator Dr. David Ganz, Chief of Party, SERVIR Mekong - ADPC Dr. Peeranan Towashiraporn, Deputy Chief of Party, SERVIR Mekong - ADPC Dr. Pete Cutter, Science and Data Lead, SERVIR Mekong – SIG
9:45-10:15	*Coffee Break*
10:15-11:15	Breakout groups (Academic/Research Institutions, NGOs/CSOs, multi/bi-laterals, private sector) Identify capacity, information and application needs in each of the following categories: Climate change Disaster risk reduction and management Land and water planning and management Ecosystem services Prioritization exercise Identifying next steps
11:15-12:00	Groups report back
12:00-12:30	Conclusions and wrap-up Overview of upcoming schedule for SERVIR
	End of Program

Appendix B. Online Questionnaire Questions

Lower Mekong Geospatial Information/ Applications Needs Assessment

Dear Sir/Madam,

Thank you for your interest in the use of geospatial data and tools for decision making in the Mekong region. We would like to get your feedback through this brief survey to learn what are the geospatial information and capacity needs in the region. With this information, we would thereby better respond to these needs through the project "SERVIR-Mekong".

This survey should take about 20 minutes to complete.

About SERVIR-Mekong

SERVIR-Mekong will help Governments and other key decision-makers in the Lower Mekong Region to take advantage of publicly available satellite imagery, geospatial data, maps and other information for more informed decisions on issues such as climate adaptation, water management, land use planning, disaster risk reduction, infrastructure development and natural resource management. The project covers the countries of Cambodia, Lao PDR, Myanmar, Thailand and Viet Nam. It is funded by USAID and NASA, and implemented by the Asian Disaster Preparedness Center and partners. Learn more at www.adpc.net/servir.

About You

Your position or title

Are you male or female?

- ☐ Female
- ☐ Male

Which of the following tools are familiar to you?

- ☐ Internet-based mapping tools like Google Earth
- ☐ Geographic Information Systems (GIS)
- ☐ Remote sensing
- ☐ Global Positioning Systems (GPS)
- ☐ none

Geospatial data refer to data that identify the geographic location of objects and boundaries on Earth. The analysis of geospatial data helps to identify trends and relationships in time and space. How often do you analyze geospatial data for your work?*

- ☐ Very frequently (e.g., every day)
- ☐ Regular (e.g., once a month)
- ☐ Seldom (e.g., once a year)
- ☐ Never

The analysis of geospatial data produces information such as maps on themes like land use, forest cover, and flood risk. These examples of information have the potential to make decision making more effective. How often do you refer to information generated from geospatial data for your work?*

- ☐ Very frequently (e.g.' every day)
- ☐ Regular (e.g., once a month)
- ☐ Seldom (e.g., once a year)
- ☐ Never

Remotely sensed data refers to data collected by sensors at a distance from the object of interest. Sensors may be carried by satellites, airplanes and other vehicles. Remotely sensed data include estimates of heights, wind speeds, current direction, quantities of chemicals, among other examples. How often do you use remotely sensed data for your work?*

- ☐ Very frequently (e.g., every day)
- ☐ Regular (e.g.' once a month)
- ☐ Seldom (e.g., once a year)
- ☐ Never

About Your Organization

Your agency or organization name

What category best describes the organization work for *

- ☐ Government
- ☐ Education/Research institution
- ☐ Nonprofit

- ☐ Multi-/Bilateral donor or technical assistance agency
- ☐ Intergovernmental organization
- ☐ Private company or professional association
- ☐ Program or project
- ☐ Independent consultant

Note: choices can be randomly listed

How often does your organization acquire for free or purchase spatial data?*

- ☐ Very frequently (more than once a year)
- ☐ Regularly (once a year)
- ☐ Seldom (less than once a year)
- ☐ Never
- ☐ Don't know

How often does your organization acquire for free or purchase remotely sensed data?*

- ☐ Very frequently (more than once a year)
- ☐ Regularly (once a year)
- ☐ Seldom (less than once a year)
- ☐ Never
- ☐ Don't know

How often does your organization publish geospatial data sets?*

- ☐ Very frequently (more than once a year)
- ☐ Regularly (once a year)
- ☐ Seldom (less than once a year)
- ☐ Never
- ☐ Don't know

How often does your organization publish documents based on the analysis of geospatial data?*

- ☐ Very frequently (once a quarter)
- ☐ Regularly (once a year)
- ☐ Seldom (less than once a year)
- ☐ Never
- ☐ Don't know

Would your organization achieve better results if it had any of the following? Please choose as many as you think appropriate.

- ☐ More computers
- ☐ More GIS software licenses
- ☐ Effective data storage
- ☐ More staff
- ☐ A bigger budget for acquiring data
- ☐ Institutional arrangements for sharing data
- ☐ Others: _____

Note: choices can be randomly listed

Would your organization achieve better results if it had a clearly stated mission for the following? You may have more than one answer.

- ☐ Geospatial data acquisition
- ☐ Maintaining one or more geospatial datasets
- ☐ Sharing geospatial data with government organizations
- ☐ Sharing geospatial data with the public

Key Issues & Challenges

This part of this survey contains questions to help SERVIR-Mekong obtain feedback on where to focus resources for developing tools to inform planning, decision making or policy setting. Follow-up questions will be based on your selections here.

Please indicate the country or region for which your responses on this survey will be most relevant. You may select more than one country.*

- ☐ Cambodia
- ☐ Lao PDR
- ☐ Myanmar
- ☐ Thailand
- ☐ Viet Nam

Note: respondents can choose more than one answer.

Geospatial technologies refer to equipment and techniques used to visualize, measure and analyze data associated with locations. Common examples are global positioning systems (GPS), geographical information systems (GIS), and remote sensing.

Please review the area that should be prioritized for attention by SERVIR-Mekong for developing applications of geospatial technologies. Your selection will be followed by area-specific questions. (Later, you will have an opportunity to suggest a second area for priority by SERVIR-Mekong).*

- ☐ Agriculture
- ☐ Biodiversity
- ☐ Climate change
- ☐ Disaster risk management
- ☐ Ecosystems monitoring
- ☐ Health monitoring
- ☐ Water management

Note: selections lead to specific follow-up questions

Agriculture

These questions will help us know the considerations for developing applications of geospatial technologies to help farmers, fishers and policy makers maximize productivity and food security, preserve the environment or support the sustainable management of agriculture.

Note: this series of questions is triggered by respondents' selection of key themes in the "Key Issues and Challenges" section

QA1. Which of the following describes the most needed geospatial application in agriculture? *

- ☐ Drought forecasting
- ☐ Crop disease management
- ☐ Agricultural yield prediction
- ☐ Soil moisture monitoring
- ☐ Water management
- ☐ Pest invasion monitoring
- ☐ Other: _____

Note: choices can be randomly listed

QA2. Who should be the direct user of the information produced by the needed application you selected? You may select more than one option. *

- ☐ Agricultural extension worker
- ☐ Farmer
- ☐ Agricultural scientist
- ☐ Planner
- ☐ Other: _____

Note: choices can be randomly listed; respondents can choose more than one answer

QA3. Men and women perform different roles for food production and promoting well-being at household and community levels, and develop different sets of experience, knowledge, talents and needs. They are differently affected by various effects of the loss of biodiversity, and may respond and cope in different ways. Women in particular may face specific constraints in their efforts to participate in decision making, own land and engage in paid labor. Please comment on how you think information on gender can improve agricultural planning or decision making.

Biodiversity

These questions will help us know the considerations for developing applications of geospatial technologies to support the conservation and sustainable use of the world's biological resources by improving the quality and quantity of biodiversity information and analysis.

Note: this series of questions is triggered by respondents' selection of key themes in the "Key Issues and Challenges" section

QB1. Which of the following describes the most needed geospatial application in biodiversity? *

- ☐ Land-use change monitoring
- ☐ Biodiversity mapping
- ☐ Environmental Impact Assessment support
- ☐ Forest cover monitoring
- ☐ Land-use planning and management
- ☐ Other: _____

Note: choices can be randomly listed

QB2. Who should be the direct user of the information produced by the needed application you selected? You may select more than one option.*

- ☐ Conservationist
- ☐ Planner
- ☐ Scientist
- ☐ Public
- ☐ Other: _____

Note: choices can be randomly listed

QB3. Men and women perform different roles for using and managing natural resources at household and community levels, and develop different sets of experience, knowledge, talents and needs. They are differently affected by various effects of the loss of biodiversity, and may respond and cope in different ways. Women in particular may face specific constraints in their efforts to access decreasing resources. Please comment on how you think information on gender can improve planning or decision making over biodiversity.

Climate Change

These questions will help us know the considerations for developing applications of geospatial technologies to achieve a fuller understanding of climate, enhance modeling, improve climate projections, and translate such into potential impacts in sectors such as agriculture, ecosystems, and water.

Note: this series of questions is triggered by respondents' selection of key themes in the "Key Issues and Challenges" section

QC1. Which of the following describes the most needed geospatial application in planning for climate change? *

- ☐ Forest cover monitoring
- ☐ Sea-level rise monitoring
- ☐ Agro-forestry mapping
- ☐ Basin-wide management
- ☐ Other: _____

Note: choices can be randomly listed

QC2. Who should be the direct user of the information produced by the needed application you selected? You may select more than one option. *

- ☐ Extension/development worker

- ☐ Conservationist
- ☐ Scientist
- ☐ Public
- ☐ Other: _____

Note: choices can be randomly listed

QC3. Men and women perform different roles for managing resources and providing for daily needs at the household and community levels, and develop different sets of experience, knowledge, talents and needs. They are affected differently a by various effects of climate change, and may respond and cope in different ways. Women in particular may face specific constraints in their efforts to cope with the negative effects. Please comment on how you think information on gender can improve planning or decision making over climate change.

Disaster Risk Management

These questions will help us know the considerations for developing applications of geospatial technologies to help planners, risk management practitioners and emergency responders reduce vulnerability, strengthen preparedness measures and understand the relationship between natural disasters and climate change.

Note: this series of questions is triggered by respondents' selection of key themes in the "Key Issues and Challenges" section

QD1. Which of the following describes the most needed geospatial application in disaster risk management? *

- ☐ Forest fire disaster management
- ☐ Early warning system
- ☐ Flood monitoring and management
- ☐ Drought forecasting
- ☐ Community-based disaster risk reduction
- ☐ Other: _____

Note: choices can be randomly listed

QD2. Who should be the direct user of the information produced by the needed application you selected? You may select more than one option.*

- ☐ Local government official
- ☐ Disaster risk management practitioner
- ☐ Extension/development worker
- ☐ General public
- ☐ Other:

Note: choices can be randomly listed

QD3. Men and women perform different roles for managing safety and well-being at household and community level, and develop different sets of experience, knowledge, talents and needs. They are differently affected by various types of disaster risks, and may respond and cope in different ways. Women in particular may face specific constraints in their efforts to mitigate the negative effects of disasters. Please comment on how you think information on gender can improve disaster risk management.

Ecosystems Monitoring

These questions will help us know the considerations for developing applications of geospatial technologies to help conservationists strengthen ecosystem monitoring over land, ocean and coast, classify ecosystems and delineate their boundaries, monitor ecosystem services, and improve efforts to combat desertification and other degradation processes.

Note: this series of questions is triggered by respondents' selection of key themes in the "Key Issues and Challenges" section

Which of the following describes the most needed geospatial application for monitoring ecosystems? *

- ☐ Land-use change management
- ☐ Ecosystem services measurement
- ☐ Forest cover monitoring
- ☐ Land cover mapping
- ☐ Pollution monitoring
- ☐ Other: _____

Note: choices can be randomly listed

Who should be the direct user of the information produced by the needed application you selected? You may select more than one option.*

- ☐ Development worker
- ☐ Ecologist
- ☐ Public
- ☐ Other:

Note: choices can be randomly listed

Men and women perform different roles for managing resources at household and community

levels, and develop different sets of experience, knowledge, talents and needs. They are differently affected by various types of environmental stresses, and may respond and cope in different ways. Please comment on how you think information on gender can improve planning or decision making for ecosystem monitoring.

Health Monitoring

These questions will help us know the considerations for developing applications of geospatial technologies to help public health professionals improve understanding of how the environment affects human health and well-being.

Note: this series of questions is triggered by respondents' selection of key themes in the "Key Issues and Challenges" section

QH1. Which of the following describes the most needed geospatial application for monitoring human health? *

- ☐ Contamination detection
- ☐ Pollution monitoring
- ☐ Health management information system
- ☐ Epidemiological analysis
- ☐ Other: _____

Note: choices can be randomly listed

Who should be the direct user of the information produced by the needed application you selected? You may select more than one option.*

- ☐ Health professional
- ☐ Community health worker
- ☐ Epidemiologist
- ☐ Public
- ☐ Other: _____

Note: choices can be randomly listed

Men and women perform different roles for promoting health and well-being at household and community levels, and develop different sets of experience, knowledge, talents and needs. They are differently affected by various types of health risks, and may respond and cope in different ways. Women in particular may face specific constraints for obtaining and understanding information about disease management. Please comment on how you think information on gender can improve planning or decision making for monitoring human health.

Water Management

These questions will help us know the considerations for developing applications of geospatial technologies to provide information products to water managers to document the location, quantity, quality, use, and distribution of water resources will be of critical importance as pressures increase on the global freshwater supply.

Note: this series of questions is triggered by respondents' selection of key themes in the "Key Issues and Challenges" section

QW1. Which of the following describes the most needed geospatial application for water management? *

- ☐ Drought forecasting
- ☐ Dam reservoir integrity and safety
- ☐ Basin-wide management
- ☐ Riverbank erosion monitoring
- ☐ Water quality monitoring
- ☐ Surface and groundwater monitoring
- ☐ Other: _____

Note: choices can be randomly listed

QW2. Who should be the direct user of the information produced by the needed application you selected? You may select more than one option.*

- ☐ Water resource manager
- ☐ Hydrologist
- ☐ Public
- ☐ Other: _____

Note: choices can be randomly listed

QW3. Men and women perform different roles for managing water resources at household and community levels, and develop different sets of experience, knowledge, talents and needs. They are differently affected by various types of water stresses, and may respond and cope in different ways. Women in particular may face specific constraints in their efforts to mitigate the negative effects of water stresses. Please comment on how you think information on gender can improve water management.

Gender and Development

Gender refers to the roles, responsibilities and expectations tied to being a woman or a man in our families, societies and cultures. However, these roles, responsibilities and expectations may create disadvantage for women and hierarchies of women and men at home, in the workplace, and in other social organizations. SERVIR-Mekong is interested in developing analytical tools for identifying gender-specific trends and other potentially useful information.

Gender analysis is the collection, analysis and presentation of information that uses gender-disaggregated data. It also traces areas of inequality and disadvantage between women and men. What kind of geospatial information can contribute to gender analysis?

How can we apply geospatial data or technologies to address gender-related development issues?

Data Quality and Sharing

Are you aware of any GIS-based datasets that are publicly available to support planning or decision making? Kindly describe the data set name and the organization that maintains it.

Is there a GIS-based dataset that needs to be created to support agricultural planning or decision making? Kindly describe the data set as comprehensively as possible.

Which of the following best describes your job function with respect to geospatial data?*

- ☐ I have a management function that benefits from recommendations based on maps, statistics or other information generated from geospatial data.
- ☐ I am a trainer who teaches others how to use geospatial tools and/or interpret the outputs.
- ☐ I am a researcher who develops computerized tools and other types of models.
- ☐ I am a GIS operator who digitizes data to produce maps.
- ☐ I am a GIS specialist who develops datasets, maps and other analytical products using GIS software.
- ☐ I am a remote sensing professional who processes remotely sensed data using ERDAS, ILWIS, eCognition, or other software.
- ☐ Other: _____

Note: respondents who answer "management" or "Other" functions will skip to "Data Sharing" questions.

Data Quality

In your experience, what are the general problems surrounding the quality of datasets available in the country? You may select more than one option.*

- ☐ I have not encountered any issues concerning data quality.
- ☐ Datasets contain errors.
- ☐ Datasets are not regularly updated.
- ☐ Datasets are not accompanied by metadata (context information about the content).
- ☐ Data collected across different areas in the country are not comparable.
- ☐ Datasets are not available in digital formats.
- ☐ No data collection framework or policy requiring specific organizations to maintain data.
- ☐ Other (please specify): _____

Note: respondents can choose more than one answer.

What are possible solutions to address the problems of data quality? You may select more than one option.

- ☐ Datasets should be accompanied by metadata.
- ☐ The State must set a framework for data collection that covers standards for accuracy, frequency and formats.
- ☐ Data portals should be given incentives to maintain metadata on datasets.
- ☐ Organizations should follow open data standards (that enable data and content to be freely used, modified, and shared by anyone for any purpose).
- ☐ Other (please specify): _____

Note: respondents can choose more than one answer.

Data Sharing

Is there an online portal that you use to obtain geospatial data?

Kindly supply the online link (URL).

In your experience, what are the general problems surrounding the sharing of datasets available in the country? You may select more than one option.*

- ☐ I have not encountered any problems with respect to sharing data among organizations.
- ☐ It is difficult to know what datasets are available.
- ☐ Organizations do not grant access to data.
- ☐ Datasets are expensive.
- ☐ Historical data are not available in digital form.
- ☐ Poor internet connectivity limits data sharing.
- ☐ Datasets are based on different standards so that integration becomes resource-intensive.
- ☐ No mechanism for sharing data among organizations working on the same problem.
- ☐ Other (please specify): _____

Note: respondents can choose more than one answer.

What are the possible solutions to address the problems of data sharing? You may select more than one option.

- ☐ Datasets should be accompanied by metadata.
- ☐ The State must set a policy for the responsible sharing of data.
- ☐ Organizations should follow open data standards (that enable data and content to be freely used, modified, and shared by anyone for any purpose).
- ☐ Organizations should be given financial or other incentives to share datasets.
- ☐ Other (please specify): _____

Note: respondents can choose more than one answer.

Capacity Development

Could you perform your work better if you had any of the following? You may choose more than one.

- ☐ Awareness of what data are available for your use
- ☐ Basic knowledge of the science relevant to your work
- ☐ Basic knowledge about geographic information systems (GIS)
- ☐ Basic knowledge about remote sensing
- ☐ Understanding of how geospatial data and analysis can inform management decisions in our organization

Note: respondents can choose more than one answer.

Kindly select the topic where you feel you need training.

- ☐ Use of GIS software
- ☐ Use of specialized instruments
- ☐ Specialized GIS-based modeling techniques
- ☐ Interpreting maps
- ☐ Analyzing spatial data
- ☐ Communicating spatial data trends or analysis to a non-technical audience
- ☐ Other: _____

Note: respondents can choose more than one answer.

Kindly select the area where you feel you need capacity building.

- ☐ Applying research results to development work
- ☐ Using relevant geospatial data or tools for planning
- ☐ Using relevant geospatial data or tools for operational decisions
- ☐ Integrating gender analysis for planning
- ☐ Integrating gender analysis for operational decisions

What form of capacity building is most appropriate for you? Please rank the following choices.

- ☐ Short training course (three days to one week)
- ☐ Long training course (two to three weeks)
- ☐ Graduate degree (masters or PhD)
- ☐ Secondment (temporary assignment) at another organization who have the experience you need
- ☐ Mentoring by an expert or senior manager

Appendix C. List of Institutional Affiliations of all Contributors to Consultations and Online Questionnaire

Organizations with Regional Scope/Mandate

Academic/Research Institutions

- Asian Institute of Technology
- Stockholm Environmental Institute-Asia

NGOs/CSOs

- International Union for the Conservation of Nature
- The Center for People and Forests
- Shared Waters Partnership
- WWF-Greater Mekong
- International Organization for Migration

Multi-/Bilateral Development Agencies

- USAID-Regional Development Mission for Asia
- Asian Development Bank - GMS Core Environment Program

UN/Regional Bodies

- United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP)
- United Nations Operational Satellite Applications Programme (UNOSAT)
- United Nations Office for the Coordination of Humanitarian Affairs
- World Food Programme

Programs/Projects

- USAID
  - Sustainable Mekong Program
    - Smart Infrastructure for the Mekong (SIM)
    - Mekong Partnership for the Environment (MPE)
    - Climate Resilient Mekong (CRM)
  - Mekong Adaptation and Resilience to Climate Change (Mekong-ARCC)
  - Lowering Emissions in Asia's Forests (LEAF)
  - Vietnam Forests and Deltas (VFD)

Private Sector/Contractor/Professional Associations

- Planet Labs

Cambodia

Government Ministries/Agencies

- Ministry of Agriculture, Forestry and Fisheries
  - Forestry Administration
  - Fisheries Administration
  - Department of Planning and Statistics
- Ministry of Environment
  - Department of National Parks
  - Department of Wetlands and Coastal Zones
  - Department of Planning and Legal Affairs
  - Department of Wildlife Sanctuaries
  - Community Protected Area Office
- Ministry of Planning
- Ministry of Water Resources and Meteorology
  - Department of Meteorology
  - Department of Agriculture
  - Department of Water Resources Management and Conservation

- Department of Administration and Human Resources

NGOs/CSOs

- Birdlife International
- Fauna & Flora International
- Khmer Youth Education Fund
- WOMEN
- WorldFish
- Evangelical Fellowship of Cambodia
- Development and Partnership in Action
- Wildlife Conservation Society
- Conservation International

Academic/Research Institutions

- Royal University of Phn0m Penh
- Royal University of Agriculture
- Cambodian Agricultural Research and Development Institute

Multi-/Bi-lateral Development Agencies

- European Union
- Deutsche Gesellschaft fur Internationale Zusammenarbeit
- Korea International Cooperation Agency
- USAID-Cambodia

UN/Regional Bodies

- United Nations International Children's Emergency Fund
- United Nations Development Programme

Programs/Projects

- Open Development Cambodia/Open Development Mekong
- Supporting Forests and Biodiversity Project (Winrock)

Lao PDR

Academic/Research Institutions

- Center for Development and Environment, University of Bern
- National University of Laos (Lao PDR)

NGOs/CSOs

- CGIAR Research Program on Water, Land and Ecosystems
- French Red Cross
- Lao Red Cross
- Wildlife Conservation Society
- WWF-Laos

Multi-/Bi-lateral Development Agencies

- Deutsche Gesellschaft fur Internationale Zusammenarbeit
- Netherlands Development Organisation
- World Bank

UN/Regional Bodies

- United Nations Development Programme
- Mekong River Commission
- World Food Programme

Program/Project

- Khammouane Development Project (KDP)

Myanmar

Academic/Research Institutions

- Mandalay Technology University
- University of Yangon

NGOs/CSOs

- ActionAid
- American Red Cross
- Biodiversity And Nature Conservation Association (BANCA)
- Community Development Association
- Fauna & Flora International
- International Organization for Migration
- Malteser International
- Mercy Corps
- Oxfam International
- Plan International
- World Vision International
- WWF-Myanmar

Multi-/Bilateral Development Agencies

- USAID

UN/Regional Bodies

- UN-HABITAT
- UNICEF
- Myanmar Information Management Unit (MIMU)

Programs/Projects

- PACT Mobile Health Project

Thailand

Government Ministries/Agencies

- Ministry of Science and Technology
  - Hydro and Agro Informatics Institute (HAII)
  - Geo-Informatics and Space Technology Development Agency (GISTDA)
  - Thailand Institute of Scientific and Technological Research (TISTR)

Academic/Research Institutions

- Asian Institute of Technology
- Naresuan University

Vietnam

Government Ministries/Agencies

- Ministry of Agriculture and Rural Development (MARD)
  - Disaster Management Center (DMC)
  - Institute of Science, Technology and Environment
  - Institute of Water Resources Planning (IWARP)
  - Southern Institute of Water Resources Research
    - Department for Science and International Technologies Cooperation
    - Research Center for River Training and Natural Disaster Prevention
- Ministry of Natural Resources and Environment (MoNRE)
  - Department of Meteorology, Hydrology and Climate Change
  - Climate Change Coordination Office of Can Tho City, Department of Water Resources, Can Tho Province
  - Ho Chi Minh Climate Change Bureau
- People's Committee of Ho Chi Minh City (Steering Center for Flood Control)

Academic/Research Institutions
**Note: some government agency-embedded research institutes listed above*

- Vietnam National University, Hanoi
  - University of Science
  - Centre for Natural Resources and Environmental Studies (CRES)
- Can Tho University
  - College of Environment and Natural Resources
    - Land Resources Department
    - Department of Environmental and Natural Resource Management
  - College of Agriculture and Applied Biology, Department of Soil Science
- Nong Lam University
  - Research Center for Climate Change (RCCC), Applied Geomatics Department
  - Center for International Education and International Cooperation Office
- Vietnam Water Resources University
- Vietnam Academy of Science and Technology (VAST)
  - Vietnam National Satellite Center (VNSC)
  - Vietnam Space Technology Institute
  - Institute of Ecology and Biological Resources (IEBR)

NGOs/CSOs

- American Red Cross
- CARE International
- International Union for the Conservation of Nature (IUCN)
- Plan International –Vietnam
- Vietnam Red Cross
- World Vision
- WWF-Vietnam

Multi-/Bilateral Development Agencies

- Asian Development Bank
- Swiss Agency for Development and Cooperation

UN/Regional Bodies

- United Nations Development Programme (UNDP)
- United Nations International Children's Emergency Fund (UNICEF)

Programs/Projects

- LEAF (USAID project implemented by Winrock)
- Vietnam Forests and Deltas (USAID project implemented by Winrock)

Private sector/Contractor/Professional Associations

- Winrock International
- VidaGIS
- Vietnam Construction Investment and Design, JSC

Appendix D. Online Questionnaire – Summary of Responses

A. Profile of Respondents

1. **By sex**

Sex	Number
Female	34
Male	19
No answer	2
Total	55

2. **Job functions of respondents with respect to geospatial data**

Job type	Number
Management	19
Lecturer/trainer	13
Specialist	9
Researcher	8
Other	2
Total	51

N = 51

3. **Country relevance of answers of respondents**

Country	Number
Cambodia	20
Lao PDR	17
Myanmar	16
Thailand	18
Vietnam	30
Total	101

N = 53

4. **Familiar digital geo-tools**

Tool	Number
Internet-based mapping tools like Google Earth	45
Geographic Information Systems (GIS)	45
Global positioning systems (GPS)	39
Remote sensing	33
No answer	1
Total	163

N = 55

B. Profile of Organization

1. **Principal industry of respondents**

Industry type	Number
Education/Research	19
Non-profit	11
Government	9
Program/Project	4
International organization	4
Private company	4
Bi-/ Multi-lateral organization	1
No answer	4
Total	55

No answer: 4

2. **Frequency of geospatial data acquisition by organizations**

Frequency	Number
Very frequently (more than once a year)	24
Regularly (once a year)	16
Seldom (less than once a year)	7
Never	1
Don't know	7
Total	55

N = 55

3. **Frequency of remotely sensed data acquisition by organizations**

Frequency	Number
Very frequently (more than once a quarter)	28
Regularly (once a year)	8
Seldom (less than once a year)	11
Never	2
Don't know	6
Total	55

N = 55

4. **Frequency of publication of geospatial data sets by organizations**

Frequency	Number
Very frequently (more than once a year)	19
Regularly (once a year)	9
Seldom (less than once a year)	11
Never	7
Don't know	9
Total	55

N = 55

5. **Frequency of publication of documents based on analysis of geospatial data**

Frequency	Number
Very frequently (once a quarter)	19
Regularly (once a year)	13
Seldom (less than once a year)	15
Never	2
Don't know	6
Total	55

N = 55

C. Applications of Geospatial Tools

1. **Priority development areas for SERVIR-Mekong**

Development area	Number
Disaster Risk Management	27
Water Management	21
Climate Change	18
Agriculture	15
Ecosystems Monitoring	9
Biodiversity	3
Health Monitoring	1
Total	94

N = 53

2. **Most needed applications**

Application type	Listed answers		Number
Management	Land-use planning and management	Water management	52
	Basin-wide management	Flood monitoring and management	
	Surface and ground water management	Early warning system	
	Dam reservoir integrity and safety	Community-based disaster risk reduction	

Data	Riverbank erosion monitoring Agro-forestry mapping Sea-level rise monitoring Forest cover monitoring	Land cover mapping Mapping vector-borne diseases Land tenure	16
Data analysis	Crop disease management Agricultural yield prediction Drought forecasting Ecosystem services measurement	Ecosystem services valuation Epidemiological analysis Flood observation/forecasting	16
Unclear	Earthquake/tsunami		1
Total			75

N = 53

3. Application end users

End user	Number
Professionals	73
Researchers	57
Public	41
Government officials	26
Farmers	9
Private sector	5
Miscellaneous	3
Total	94

N = 53

4. Most needed geospatial application for planning in agriculture

Applications	Number
Water management	7
Drought forecasting	3
Crop disease management	3
Agricultural yield prediction	1
Other (please specify): land tenure	1
Total	15

N = 15

5. End user of agriculture planning application

End user	Number
Agricultural scientist	13
Agricultural extension worker	9
Farmer	8
Local government	3
Private sector	2
Land occupants	1
Total	36

N = 15

6. Most needed geospatial application for monitoring biodiversity

Applications	Number
Land use planning and management	2
Forest cover monitoring	1
Total	3

N = 3

7. End user of biodiversity monitoring application

End user	Number
Conservationist	1
Public	2
Total	3

N = 2

8. Most needed geospatial application for planning for climate change

Applications	Number
Basin-wide management	8

Agro-forestry mapping	4
Sea-level rise monitoring	3
Forest cover monitoring	1
Mapping vector borne diseases	1
All of the above	1
Total	18

N = 18

9. End-user of climate change planning application

End user	Number
Scientist	15
Public	12
Conservationist	9
Extension/development worker	9
Land use committees	1
Private sector	1
Government	1
Total	48

N = 18

10. Most needed geospatial application for disaster risk management

Applications	Number
Flood monitoring and management	12
Early warning system	7
Community-based disaster risk reduction	5
Drought forecasting	2
Other: earthquake/tsunami	1
Total	27

N = 17

11. End-user of disaster risk management application

End user	Number
Disaster risk management practitioner	21
Local government official	19
Extension/development worker	9
Public	7
Researchers	1
Farmer	1
Total	58

N = 17

12. Most needed geospatial application for monitoring ecosystems

Applications	Number
Land use change management	2
Ecosystem services measurement	2
Forest cover monitoring	2
Land cover mapping	2
Total	8

N = 5

13. End-user of ecosystem monitoring application

End user	Number
Ecologist	6
Development worker	6
General public	4
Government	3
Private sector	1
NGOs	1
Total	21

N = 5

14. Most needed geospatial application for monitoring human health

Application	Number
Epidemiological analysis	1

15. End-user of health monitoring application

End user	Number
Epidemiologist	1
Health worker	1
Health professional	1
Public	1
Total	4

N = 1

16. Most needed geospatial application for water management

Applications	Number
Basin-wide management	8
Surface and ground water management	7
Riverbank erosion monitoring	2
Drought forecasting	2
Dam reservoir integrity and safety	1
Flood observation/forecasting	1
Total	21

N = 23

17. End-user of water management applications

End user	Number
Water resource manager	17
Hydrologist	11
Public	8
Agroforestry companies	1
Total	37

N = 23

D. Geospatial Information for Gender and Development

1. Geospatial information that can contribute to gender analysis

Type of information	Examples of listed answers	Number
Spatial information disaggregated by sex/gender	Resource user patterns / time-cost (e.g., travel paths), disaggregated by gender. Sex-disaggregated data analysis could be easier through maps Communal gender rate	6
Socio-economic data	Include the information on ratio, population, density Workforce employment General access to facilities pre- and post-disaster	5
Data on land, land use and related livelihood	Locations of community forests and community protected areas, which often have a significant percentage of women as members Local livelihood reveals life patterns of local communities. Land use, land cover, topography, population distribution map	4
Miscellaneous		5
Don't know		7
No need		1
Total		28

N = 25

2. Geospatial tools for addressing gender-related issues

Type of tool	Listed answers	Number
For spatial analysis of gender data	Inject remotely sensed images as evidence-based proof for women, because in Asian communities, women play important roles in homecare and community care. Using spatial analysis for identifying the role of women in decision making process Would be ideal for measuring the incidence of disasters (such as floods or typhoons) on male/female and create strong maps of the findings to support gender advocacy in the region Land use, land cover can help to predict gender type/proportion working on land Topography can affect the proportion of male/female/work/temporary living on land	4

	Population distribution map: Show proportion of male/female in a specific area	
For gender-specific planning	To locate the appropriate mitigation plan, which is different for male and female. Apply to development of climate change projects with specific gender components Analysis and query data to recognize relative problems	3
For capacity development	Development capacity building technologies Enhance knowledge and skill Treat women equally to men in terms of training and knowledge extent in long term Give them a chance to engage in local decision making and to collaborate on local projects	3
Miscellaneous		4
Don't know		7
No need		1
Total		22

N = 22

3. Suggested uses of gender information for planning and decision making

Type of use	Examples of listed answers	Number
To raise involvement of both men and women in (local) decision making	• Good understanding of their capabilities will help both female and male to clarify their own roles for disaster risk management • Early-warning systems must reach out to everyone, not only males/heads of families • Make sure that men and women understand the context and are able to actively participate, join in decision making and enjoy equal benefits from the project	16
To gather and disseminate information	• Ensuring that women gain access to information in simple, understandable format, and in local languages will better ensure that the HH/family and close members of the community also benefit and be able to make better-informed decisions • Women can provide information in terms of water quality. Men mainly prefer to discuss and comment in terms of quantity • Women are more engaged in watering for crops (e.g., coffee), so they should be trained in water-saving technology, should know how much water should be used (through drought forecast) and should know the pricing of water	12
To understand gender-differentiated impacts	• The behaviour and roles of both men and women at the community levels in normal situations should be studied and that information then used as a basis for planning decision making. From that basic information, the roles of men and women can be planned for all phases of disaster management (preparedness, response, recovery) • Information on gender can improve the quality of climate change projects that address the specific needs of women and ensure that their specific input to project development and implementation is used to the best advantage • Women are adversely affected when men migrate to seek economic opportunities, leaving behind a higher workload for women (household maintenance, child care, livestock management and agriculture)	8
Miscellaneous		6
No need		5
Total		47

N = 26

4. Function of respondent

Function of respondent	Number of suggestions
Management	20
Lecturer	12
Researcher	7
GIS Specialist	6
Other (consultant)	2
Total	47

N = 26

E. Data Quality and Sharing

1. Awareness of GIS-based datasets

Type of dataset	Number
Maps	16
GIS/RS data	7
Portals to data	6
Don't know	3

Unclear answer	1
Total	33

N = 33

2. GIS dataset that needs to be created

Dataset	Number
Hydro-meteorological dataset	6
Agricultural dataset	5
Land use/land cover dataset	3
Miscellaneous	7
Unspecified answer	3
Don't know	2
Total	26

N = 25

3. Identified general problems for data sharing

Problem	Number
It is difficult to know what datasets are available	33
No mechanism for sharing data among organizations working on the same problem	30
Organizations do not grant access to data	29
Datasets are based on different standards so that integration becomes resource-intensive	29
Historical data are not available in digital form	28
Datasets are expensive	24
Poor internet connectivity limits data sharing	13
No problems encountered in sharing data among organizations	5
Others	2
Total	193

N = 46

4. Possible solutions for data sharing

Solution	Number
Organizations should follow open data standards	39
The State must set a policy for the responsible sharing of data	35
Datasets should be accompanied by metadata	30
Organizations should be given financial or other incentives to share datasets	20
Other	1
Total	125

N = 47

F. Capacity Development

1. Respondents' desired general knowledge

Type of knowledge	Number
What data are available	35
Basic knowledge of relevant science	21
Basic knowledge about GIS	22
Basic knowledge about remote sensing	24
How geospatial data and analysis informs decisions	31
Total	133

N = 45

2. Respondents' desired training topics

Training topic	Number
Use of GIS software	13
Use of specialized instruments	10
Specialized GIS-based modelling techniques	25
Interpreting maps	17
Analysing spatial data	31
Communicating spatial analysis to general audience	22
Total	105

N = 43

3. Respondents' area of desired capacity building

Area	Number
Applying research results to development work	24
Using relevant geospatial data or tools for planning	26
Using relevant geospatial data or tools for operational decisions	28
Integrating gender analysis for planning	11
Integrating gender analysis for operational decisions	14
Total	103

N = 44

4. Preferred form of capacity building

Form of capacity building	Ranks					Average rating	Final rank	N
	1	2	3	4	5			
Short training course (three days to one week)	25	6	6	3	6	2.11	1	46
Long training course (two to three weeks)	12	17	10	6	1	2.28	2	46
Graduate degree (Masters or PhD)	4	6	12	5	19	3.63	5	46
Secondment (temporary assignment) at another organization that has the experience you need	1	8	11	21	5	3.46	3	46
Mentoring by an expert or senior manager	4	9	7	11	14	3.49	4	45

N = 46

Appendix E. Summaries of Documents Reviewed

1. AFOLU Working Group (2014). Technical Workshop on Integrating Forestry, Wetlands and other Land Use/Land Cover data for Greenhouse Gas Reporting. Report. Retrieved from: http://prod-http-80-800498448.us-east-1.elb.amazonaws.com/w/images/4/47/Jakarta_AFOLU-WG_Final_Report.pdf**.**	
Data Gaps	Major holes in wetland data for GHG calculation, even though they are a major sink More needed on the integration of remote sensing and ground plots to developing National Forest Inventory (NFI) processes Lao PDR – large data void
Data Sharing	Recognition by majority of workshop participants that institutional arrangement, policies and cross-agency data sharing were not adequate. Classification of datasets into one of the 6 IPCC classes for cross comparison to IPCC GHG work Vietnam – competing ministries for conduct of GHG work. Overlapping policies and practices between agencies needs to be ironed out
Capacity building	GHG estimates for most countries still using 1996 IPCC guidance needed for updating Inter-country training/sharing of how to undertake different land cover estimates, such as 30M landscape and 10M SPOT for forests and plantations. Training and technical materials are needed in each language of the country. Lao PDR – shortage of skilled staff in GIS. Funding arrangement for GIS conduct need additional management. Cambodia – technical skills shortage needs training. Demonstration project on ground as a learning-by-doing approach. Assistance needed with national funding arrangements for GIS as it is not straightforward. Vietnam – assistance with technical skills in RS capacity for multi sensor integration, and the alignment between competing ministries.
Demand	There is a general set of themes indicating the need for integrating policies across agencies as well as overlapping issues to be sorted. There is also a direct link for demand and funds. There is limited financial support to create and develop forest datasets for GHG estimations.

Other Key Point/Observations

Most countries in the region work without complete land use data sets needed for carbon accounting.

The themes most relevant to SERVIR ranged from the low end to the high end of the scale.

At the data end of the spectrum the Lao PDR indicated that there is a clear shortage of data, in land cover and forestry applications.

Moving along the scale, Lao PDR and Cambodia both indicate a need for technical training and it would appear that the training is along the continuum from data collection to pre-processing, analysis and application use.

At the higher end of the scale Vietnam indicated that it needs support with the integration of multi-sensor data sets to give clarified nationally consistent datasets (it appears that they have a relative strength in underpinning base skills as compared to the Lao PDR and Cambodia).

On the demand stream, there are clearly institutional and policy barriers limiting data capture and analytics for forest cover and GHG. This indicates that these processes are of limited national priority.

Vietnam indicated challenges with overlapping ministries. Streamlining and harmonising institutional arrangements and policies will clearly see improvements in data availability, but maybe not in usage.

Cambodia did mention that it would like to see a pilot project for a learning-by-doing outcome.

2. Asian Development Bank (2014). Space Technology and Geographic Information Systems Applications in ADB Projects. Retrieved from: http://www.adb.org/sites/default/files/publication/148901/space-technology-and-gis-applications-adb-projects.pdf**.**	
Data Gaps	Not discussed

Data Sharing	Not discussed
Capacity building	Projects completed • River basin Management in Vietnam • Agricultural and rural statistics – All Mekong countries • CORE Agriculture Support Program - All Mekong countries, improved data for food, agriculture, transport, energy (multiple underlying datasets). One output was drought monitoring. • Flood modelling in Vietnam • Biodiversity corridors in Thailand More generally ADB GIS team has an extensive natural resources data sets and maps (more than 1,000) across the region.
Demand	ADB projects have covered the full spectrum of sectors (DRM, infrastructure, agriculture, urban, energy, climate change etc.)

Other Key Points/Observations

This report is a sharing of ADB projects in GIS and space technology to date. It is not an analysis of what is needed, but rather a compilation of what they have done.

In summary, the ADB team does have an extensive group of datasets that have been used for a wide array of national scale analytics for agriculture transport, energy drought monitoring.

It is apparent that ADB is a crucial SERVIR partner. And discussions surrounding data sharing will be essential. Its likely many of the data sets will be at too high a scale to be useful at local levels and ADB data could be augmented with localised data.

In addition, ADB has a clear and open relationship with JAXA and again JAXA could be a SERVIR partner going forward.

3. Department of Survey and Mapping, Ministry of Natural Resources and Environment (2011). Vietnam Report on Development of Geospatial Information System. Retrieved from: https://ggim.un.org/docs/meetings/Forum2011/CRP%20no.%201_Viet%20Nam%20country%20report.pdf.	
Data Gaps	Current data sets that exist are noted as: 1:10,000 DEM for the whole of Vietnam 1:2,000 and 1:5,000 for urban, industrial and important economic zones
Data Sharing	The standards being applied to datasets are in accord with ISO/TC211, which was set out in a 2007 National Regulation. There are policies regarding some aspects of survey and topographic data
Capacity building	Not discussed
Demand	Historically there was not a national approach to geospatial data, but rather projects and agencies are doing things themselves. It appears the MONRE Department of Survey and Mapping has changed that across the period 2007 to 2012 with standards and regulations.

Other Key Points/Observations

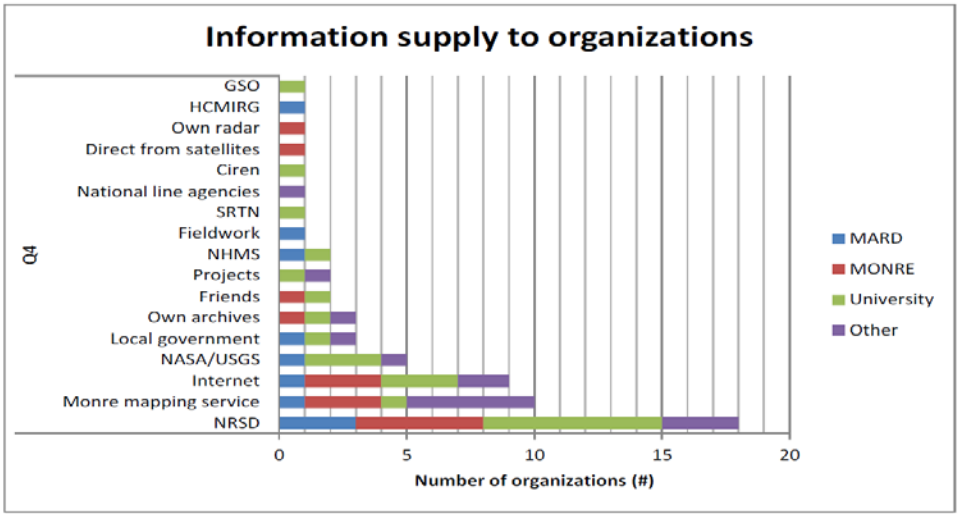
This is a short report (4 pages) developed by a MONRE (Department of Survey and Mapping) staff person to an international GIS forum in Korea in 2011.

It appears that the scope of the Survey Department data and management is around topographic data, geodesic points, cadastre and administrative (political) boundaries. There was no description of land cover, forest cover or agriculture information per se.

It appears there is likely a well-established data set within the department for DEM and other boundary features.

SERVIR-Mekong may be able to work with this Department to uncover their program for data improvement as well as data sharing possibilities, particularly if it is the official host of boundaries (cadastre and political).

4. van de Giesen, N. et al. (2013). Survey of needs for Water and Climate Services in Vietnam.

Data Gaps	There is a useful chart on page 12 (see below) indicating the "data source" by provider and who is using the various data sources. 
Data Sharing	There was a very clear recognition of the need for stronger data sharing, horizontal and vertically.
Capacity building	It was noted that there is a gap between end users and modeller organisations, and therefore a gap in "needs verses development". This was following a review of 27 separate institutions. There is a recognized gap in hardware and ITC connectivity across the country with internet services being too slow for readily accessible real time services for hydrometeorology. There is a general lack of awareness on open source software as well as a lack of awareness of just how much data is out there and who has it. There is recognition of a training/skills gap in RS capability. A series of pilot projects were proposed and one looking at flood management and irrigation in the red river (north) was determined to be the choice of a hands on project to conduct a "learning by doing approach"
Demand	The report initiates with the impression that RS data is captured, managed and disseminated to clients predominantly via the National Remote Sensing Department (NSRD). It then goes on to explain that there are more than a dozen sources of RS and GIS data across the various institutions, NGOs and private sector. NSRD provide raw data as well as end user products (maps) depending upon the client needs, classification and capability to process data.

Other Key Points/Observations

This is a report by a university team working on a G2G opportunity between the Netherlands and Vietnam. The study is dominated by an assessment of gaps and needs for water management and hydro-meteorological data and services. The report does not place emphasis on land use/land cover/agriculture data needs as this was not the focal area. It is very good with regard to hydro-meteorology.

Overall, the report gives a distinct impression that there is a national approach in place, but it might be a little outdated or a little behind current technology, open source software and taking advantage of the rapid evolution of RS data and modelling opportunities.

There is an impression that no one really has a strong appreciation of all the different datasets that are created, where they are or how they might be shared and utilized by others.

A comment was made with regard to the GIZ WISDOM training program, which is a longer term program or education and training (not short seminars), and that this was felt to be a better training pathway.

5. Ministry of Environmental Conservation and Forestry, Myanmar, The Smithsonian Institution, USA and World Wildlife Fund (2013). Geospatial Analysis Training and Strategic Planning Workshop in Myanmar, 17-25 June 2013. Workshop report. Retrieved from: http://www.geggmyanmar.org/wp-

	content/uploads/2014/08/MOECF-SI-WWF-Myanmar-Geospatial-Conservation-Training-WS-Draft-Report-Sept-30-2013.pdf.
Data Gaps	A wide array and land cover, land use and biodiversity gaps were identified. Notably missing was mention of water, hydro-meteorology and agriculture resource information (the workshop was developed with the Department of Forestry and there was little to no interaction with the water and agriculture resource sector)
Data Sharing	There are almost no mechanisms for data sharing online and most is done via hard copy map or disc transfer
Capacity building	For most departments there were gaps in human, technical and equipment to manage RS and GIS data. The Science and Technology Department has capacity in RS and GIS but is siloed off from other agencies. MOECAF has RS/GIS capacity and is working on LULC aspects but can only share data on large-scale or hard copy maps, hampering sharing and wider use. It seems that MOECAF is the strongest RS and GIS department and it would seem relatively weak in overall capability.
Demand	There a desire to begin to create a national geospatial data set and update it as needed. There is not the current capacity for existing departments to undertake this; however, projects from the EU and Swiss are working to create underlying data sets and bring together a coordinated national structure of geospatial architecture, hardware and software.

Other Key Points/Observations

This is a report on a training workshop as opposed to an assessment of needs. However, a one-day discussion was held with government agencies to gain an appreciation of current capacity and future needs, and it is clearly apparent that in the forest cover, land use and environmental sector there are clear needs across the spectrum to build capacity..

A survey of participants occurred with the results indicating a general use of ESRI and Google map-based software and products. Open source software did not feature strongly in the discussion. Significant gaps in hardware access were noted, along with people skills and raw source data of increasing granularity and accuracy.

6. Netzer, M. and E. Swails (2010). Summary of Needs Assessment for Regional Cooperation of LMS Countries for REDD+.	
Data Gaps	Lao PDR – There is some forest cover data, but not suitable capacity to turn forest data into carbon stock data and therefore there are gaps in carbon stock assessments. There appears to be a reasonable set of landform, road and general data, BUT no metadata are attached so accuracy, date and other vital information is missing. There were two land cover assessments in 1992 and 2002, which were captured using different methods and not adequate metadata, so are not comparable from a monitoring perspective. Cambodia – there are multiple forest datasets and they have recorded standards and accuracy, but for REDD+ there is limited skills to move the data into carbon stocks. There are several land cover data sets but the metadata on standards for collection accuracy and validation are not available. Thailand – it was reported that Thailand has a suitable amount of RS and GIS data for forest and land cover and REDD+ carbon stock assessments. Vietnam – Vietnam does have some land cover and forest maps but they are not consistent. More effort is needed to create standardised data collection, sharing and metadata.
Data Sharing	Not discussed
Capacity Building	Lao PDR – noted that the forest-based GIS staff have basic GIS skills, but that they lack in advanced skills and very limited capacity to undertake RS analytics necessary for REDD+.

	A significant shortage of software and hardware to facilitate carbon stock calculations was noted. There is suitable forest and ground inventory staff, but not suitable capacity to convert forest data into reliable carbon stock data. Cambodia – for REDD purposes it was reported that Cambodia has a small number of highly-skilled people and very little capacity to support. There are recognized gaps in all aspects of hardware, software, internet access, and people skills. Thailand has a good range of GIS and RS skills across the board, but for carbon stock purposes it is missing the policy mandate. It is reported that Thailand appears to have a range of agencies and institutions with the skills and also with suitable data sets to create a national forest and land cover assessment with potential for carbon stock calculation. Vietnam is lacking software, hardware and most of the skills needed. There are a very small number of very skilled analysts and a large gap for more general RS and GIS work.
Demand	Not discussed

Other Key Points/Observations

This is a study of the Lao PDR, Cambodia, Thailand and Vietnam capacity for creating the data necessary to establish REDD+ projects and monitoring. It was a study toward the RS and GIS capacity on a national scale for REDD+ as opposed to consideration of overall GIS capacity

Lao PDR. Forest databases are in different formats across time and therefore not readily comparable for monitoring.

There is a general lack of capacity, equipment and software to enable forest data to be converted to carbon stock data

Cambodia. Cambodia has moderate forest datasets (but no metadata) and very limited skills to move it from forest data to carbon stock data.

Thailand. Thailand is regarded as the most advanced in RS and GIS among the LMR countries. It is perceived that there are sufficient data across the national scale to be useful and that there is sufficient skill (junior staff through to PhD) and equipment to run and manage the RS and GIS needs

Vietnam. Vietnam seems poised to be able to capture RS and GIS capacity but is lacking in hardware, software and internet reliability as well as having a limited number of people with higher end skills and training.

LMR region. It was recommended that for REDD+ carbon calculations a regional approach and structure support, and geospatial analytics could support a better outcome across the four countries.

7. SEA-CC Net and Adaptation Knowledge Platform (2011). Desktop Study on Assessment of Capacity Gaps and Needs of South East Asia Countries in Addressing Impacts, Vulnerability and Adaptation to Climate Variability and Climate Change. Retrieved from: http://www.climateadapt.asia/upload/publications/files/4e1aba053931aDesktop_Study_Vulnerability_&_Adaptation.pdf.	
Data Gaps	Lao PDR – advanced statistical and hydrological and water balance data and models are not available. The gaps identified in the report are predominantly “output” gaps such as “crops that can withstand changed climatic conditions”. While these analyses are highly reliant upon geospatial data and models to predict climatic variability and change and species distribution ranges, the report does not delve into the data or modelling facets of the “output” needs. This is not a criticism but rather an understanding of how the report was compiled for the end-users (national policy analysts) as opposed to a technical research and development community in RS and GIS.
Data Sharing	Not discussed
Capacity building	Not discussed
Demand	Not discussed

Other Key Points/Observations

This report is very high-level and does not discuss detailed RS and GIS gaps per se. It focuses on national strategies and "needs for change" to bring about adaptation and mitigation in relation to climate change issues in the water sector.

This report begins with a focus on water stress and flooding. It then links agriculture and food security to these focal areas and finally to climate change mitigation and adaptation issues.

The high-level nature of the report does not offer clear useful guidance for RS and GIS priorities by theme. However, it is suggested that a single agency or cluster of agencies come together to create the mandate for a specific theme and then work backward to identify the data gaps and RS/GIS needs for that theme.

8. SERVIR Program Demand Activity (2013). Lower Mekong Geospatial Assessment.	
Data Gaps	Lao PDR and Vietnam – data access to RS/GIS tended to be tied to a donor-supported project more so than a determined government decision. Thailand - while more advanced in data capture and skills, the higher costs of higher resolution data were noted as an impediment.
Data Sharing	Data sharing within and among ministries is noted as difficult and often data is "sold" between ministries in the same country. Concerns of security risk and data sharing are apparent, especially in border regions where forest data could be exploited for illegal purposes.
Capacity building	Region – there is generally a better capacity for RS and GIS for hydro-meteorological data that is monitoring daily flux activities as well as linked to flooding. The next level of capacity tends to be facilitated in the disaster management sector leveraging first the flood information and then other disasters. Third, there is a moderate level of forest and land cover understanding driven by the REDD+, conservation and environmental communities. There is a long list of capacity building needs across the three countries (across all parts of the data/analysis spectrum). BUT the most important note was that more training will not necessarily translate to an increase in demand.
Demand	Thailand – it was noted that the high-level, high-quality institutions conducting RS and GIS analytics get most of their funding from the Government. However, this is at the central level and the capacity diminishes rapidly at the provincial level. Vietnam and Lao PDR noted that the highest levels of demand, capacity, access, software and hardware were centered on donor-based projects. However, the capacity dissipates after the project finishes.

Other Key Points/Observations

This report is the pre-cursor regional assessment report for the SERVIR-Mekong project.

General points and detailed country analysis is highly relevant to this needs assessment.

A priority recommendation of the report is to create a regional partnership of data and capacity through several institutions seen as regional leaders including the Asian Institute of Technology and the Mekong River Commission.

Donors explicitly supporting development geospatial data, technologies, applications, and capacity building in the region include Norway, Finland, ADB, JICA and European Commission.

The WISDOM project in Vietnam (supported by the German Space Agency) has created a series of linked tools for social economic development.

9. United Nations Economic and Social Commission for Asia and the Pacific (2007). Space Technology Application Capabilities, Facilities and Activities in Asia and the Pacific: A Regional Inventory, 2007. Retrieved from: http//www.unescap.org/icste/pubs/st_ESCAP_2463.pdf.	
Data Gaps	Not discussed
Data Sharing	Not discussed
Capacity Building	Not discussed

Demand	Not discussed

Other Key Points/Observations

This is a summary report of RS and GIS activities in more than 15 Asia and Pacific countries. In the case of the Lower Mekong countries it only mentions Myanmar, Thailand and Vietnam, and misses Lao PDR and Cambodia.

Myanmar – There is one page of information only, and the only insight noted is the list of "space agencies" to which Myanmar is signatory to, and of note for SERVIR-Mekong are the following committees:

- Committee on Earth Observation Satellite (CEOS)
- Group on Earth observation (GEO)
- Asian Association on Remote Sensing (AARS)
- Permanent Committee on GIS Infrastructure for Asia Pacific (PCGIAP)

Thailand – The focus of information delivered in the report is based on the management and development of satellites themselves (and much on mobile communication satellites as well as RS date for defence use and purpose).

Thailand is noted as having more than 20 years of RS and GIS capacity, and is regarded in the region as an advanced RS and GIS country for development and use of data and technologies.

There is only a short section on "projects and projects", which discuss products developed from the data sets available for forest, land use, agriculture and other products delivered by the various agencies. The products developed can be classified into:

- Disaster risk assessment and monitoring (flood, landslide, drought and forest fire burned area);
- Natural resource assessment and monitoring (mangrove and shorelines, seas surface temperature and monitoring of cadmium contamination);
- Agriculture assessment and development (rain-fed rice production, agriculture land reform, crop mapping);
- Land use (land cover and land-use mapping, forest change mapping).

It is apparent that Thailand (in 2007 when this report was written) has already made significant progress toward the use of RS and GIS technologies for decision making in the areas of DRM, agriculture, land use etc.

Vietnam - noted that its majority of focus for RS technologies had been in the areas of hydro-meteorology, flood monitoring, fire monitoring and forecasting, topographic maps, agriculture and land cover assessments.

10. Recommendations of the Geospatially Enabling Community Collaboration (GECCo) workshop (2014).	
Data Gaps	Not discussed
Data Sharing	An NSDI is proposed as a platform from which to capture and disseminate shared data. Recommendation to create a series of peer-to-peer data share systems as well as a person-to-person network between departments to facilitate the data sharing.
Capacity building	It was noted that the greatest impacts on geospatial use for DRM was perceived to be via people capacity building, and that the technology was not so much the limiting factor compared to people being able to collaborate easily and share data
Demand	There is potential for the demand to come from within the DRM ministries to create the NSDI, the data capture, data share protocols and networks to see this happen at the national, provincial and district levels. This was a recommendation of the report in late 2014, assimilation of which may only now be occurring within the appropriate ministries for potential acceptance (SERVIR can follow up on this aspect).

Other Key Points/Observations

This is a focal report on Vietnam from a UNSPIDER effort to assist the Vietnamese disaster management community take greater advantage and use of geospatial information to better prepare for and respond to disasters.

The meeting and report are only just over six months old and it is likely that not enough time has passed to enable the outcomes of this report to yet be fully considered and promulgated among relevant ministries. However, it is clear that the prospect of an NSDI, data standards and data share protocols are open for strong consideration. The report goes so far as to establish the possibility of the NDSI being replicated at provincial and district levels along both horizontal and vertical data and information integration.

While this report begins from the DRM community needs, it is clearly noted and recognized that an NSDI (and all the ancillary protocols) will have far-reaching national benefits in agriculture, forestry, water etc.

It perceived this initiative via UNSPIDER could be collaborated and corroborated via SERVIR to assist with the evolution and implementation.

11. Report of the Technical Advisory Mission to Vietnam (2013)	
Data Gaps	There were no specific data gaps identified in the report as it was a high level mission not detailed data analytics per se
Data Sharing	The report provides a clear understanding the data sharing capacity, which at present is low and can be enhanced
Capacity Building	The report notes the need for short- and long-term training and peer-to-peer learning outcomes
Demand	It is apparent that the work of UN-SPIDER across the DRM sector has generated a government agency knowledge base on what RS/GIS can do to add value to Vietnam, and it is apparent that underlying interest and potential demand is being generated from UNSPIDER's work.

Other Key Points/Observations

This is a UN-SPIDER technical advisory mission assessment of needs within Vietnam on space-based data and technology towards DRM. It appears to have been a precursory assessment (in 2013) which was followed up by a second supporting assessment in 2014 (above).

The report in itself is a high-level series of assessments with various Vietnamese stakeholder agencies and a series of recommendations on what areas of support and connection UNSPIDER can offer together with collaboration with Vietnam. There are some overarching themes that are consistent with SERVIR-Mekong, including:

- Policy coordination – which aims to share guidance towards:
  - Agency collaboration;
  - NSDI; and
  - SOPs for geospatial data for DRM.
- Data Access and Sharing – with aims to create and disseminate data and products amongst agencies:
  - Focal points;
  - Data standards;
  - Servers;
  - Process / SOPs.
- Capacity building:
  - Core team with high-level training in RS/GIS;
  - Short duration courses;
  - Long duration institutional peer-to-peer partnering.

12. Report of the Technical Advisory Mission to Myanmar (2012)	
Data Gaps	Due to the high-level nature of the report it is difficult to get a guide from this report as to what data gaps are present.
Data Sharing	Data sharing, networking and collaborative data access across agencies was recognized as a gap.
Capacity building	Capacity development was focused on the Myanmar Rural and Resettlement Department (RRD) as the focal point to create capacity.
Demand	The assessment is an exploratory assessment, and while invited by the Myanmar Government there did not appear to be a clear mandate from any one agency or group of agencies to establish the focal demand and point connection to RS/GIS data for DRM activity response as well as mitigation planning.

Other Key Points/Observations

This report is a UN-SPIDER technical advisory assessment of needs and support actions within Myanmar to make greater use of RS/GIS toward DRM (conducted in 2012). It appears to be a very early stage exploratory assessment and quite high level, but does touch on all the same thematic areas of understanding towards SERVIR-Mekong.

There does not appear to be a point source of RS/GIS agency in Myanmar to manage and handle RS/GIS data that is available and accessible via international charter (via United Nations and affiliate agencies). All the external agencies and participants are available but as yet not engaged with Myanmar, and Myanmar needs to establish its focal agency, policies and mechanisms to engage fully with this opportunity.

The USGS personnel within the mission actually handed across a hard disc of more than 500 GB of data including Landsat, Orbview,DEM (at 30 m) and other data (which seems to indicate that Myanmar had not, at that juncture, utilized in order to benefit from the availability of such data.

The SERVIR-Mekong project can follow up with UN-SPIDER to find out the status of any activities under this TAM with RRD. It is perceived that agencies such as MIMU and the newly-established One Map Myanmar project may have moved some of the RS/GIS linkages in Myanmar, but the opportunity to utilize the UNSPIDER basis for data support and collaborative training could be a sound opportunity to SERVIR to engage.

13. US Forest Service (2011). Climate Change in Vietnam: Assessment of Issues and Options for USAID Funding. Retrieved from: http://www.usaid.gov/sites/default/files/documents/1861/vietnam_climate_change_final2011.pdf.	
Data Gaps	Not discussed
Data Sharing	Not discussed
Capacity building	Not discussed
Demand	Not discussed

Other Key Points/Observations

This is an assessment report from USFS and USAID (conducted in 2010) into opportunities for supporting Vietnam in the areas of climate change and sustainable landscape management.

The report does not in itself develop any understanding of the RS/GIS background in Vietnam or the agencies and platforms in place or needed. However, it gives a clear appreciation of the breadth and depth of landscape activities and projects working in Vietnam and, by extension, each of those projects will have a significant reliance upon various data sets and data needs to guide them and make decisions.

Using the understanding that, by extension, the project will require underpinning data, the sectors noted in the report were water, agriculture/forestry and DRM.

14. Cambodia Rapid Assessment. Retrieved from: http://www.leafasia.org/sites/default/files/public/resources/RapidAssessment_Cambodia_Public_Final.pdf	
Data Gaps	Not discussed
Data Sharing	Not discussed
Capacity building	Not discussed
Demand	The REDD+ efforts are a clear pull mechanism for land use, land cover and land tenure data sets on a national scale. If there is ongoing work that Governments want undertaken in the REDD+ sector this can be used as an effective pull mechanism

Other Key Points/Observations

This report is a compilation study of the LMR countries for USAID LEAF needs assessment. The report is aimed at understanding the drivers of deforestation, land cover and forest loss associated with land use and forest practices. As such, it does not delve into the data sets that are available, how they are shared or the capacity of the agencies to manage or maintain the data.

However, the report can be used as a “rear-view mirror” approach as to what data might be available. By interpretation, via the status of various REDD+ and forest cover change reports, it is likely that for forest coverage land use data there are broad-based national data sets available or developed. The primary sources of this dataset are via FAO (2010) and Hansen (2010) as well as some country reports to UNFCCC. The reports generally cover possible data sets for land-based activities and may include:

- Carbon stock assessments;
- Smallholder land use data;

- Forest permit data; and
- Agricultural data

15. Country Assessment Report for Cambodia. Retrieved from: http://www.preventionweb.net/files/33988_countryassessmentreportcambodia[1].pdf.	
Data Gaps	There are large gaps in hydro-meteorological data knowledge in Cambodia as described in the report, across all sectors of agriculture, DRM, forestry, energy.
Data Sharing	
Capacity building	There are significant equipment and people gaps, for both of which it is planned to provide support by project elements. There are significant people capacity gaps in the ability to capture and analyse data.
Demand	There is a very strong need for improved hydro-meteorological services for DRM and agriculture, which may prove to be useful demand drivers. But also included are possible drivers from air sector, transport, energy, tourism, insurance, health, water, environment, military, climate change and media.

Other Key Points/Observations

The report is an assessment of the hydrometeorology services and capabilities found in Cambodia, as well as recommendations for taking this forward. In summary Cambodia is in need of far reaching and broad support services in hydro-meteorology to upgrade its service and capabilities.

16. Country Assessment Report for Lao PDR. Retrieved from: http://www.unisdr.org/files/33988_countryassessmentreportlaopdr[1].pdf.	
Data Gaps	The report indicates that Lao PDR is lagging behind its regional partners in all facets of hydro-meteorological services and can only provide the more basic services at present. The core gaps were noted as capture of raw data, analysis and dissemination (the whole package).
Data Sharing	Data sharing of observed data was noted as needing to be shared both internally as well as with international met organisations for global modelling and forecasts.
Capacity building	There is a clear note on both equipment and people resources that require investment.
Demand	The demand drivers are clear from all sectors of need in the Lao PDR, including DRM, agriculture, air services, transport and energy.

Other Key Points/Observations

This is an assessment report on the state of affairs and needs for improved hydro-meteorological services in the Lao PDR. In summary, the Lao PDR is in need of far-reaching and broad support services in hydro-meteorology to upgrade its service and capabilities.

17. Assessment Report for Viet Nam (2013). Retrieved from: http://www.unisdr.org/files/33988_countryassessmentreportvietnam[1].pdf.	
Data Gaps	There are currently seven field hydro-meteorological stations in Vietnam and, under an investment program discussed in the report, a further eight are planned. These additional stations will offer strong coverage in the Lao PDR and Cambodia for base data as well.
Data Sharing	Vietnam is planned to be established in strength in hydro-meteorology and will be in a strong position to support data sharing and analytics to the Lao PDR and Cambodia due to the reach of the observation services.
Capacity Building	Vietnam challenges – physical infrastructure, human resources, institutional arrangements, policy and technology advances. There is a long list of needs ranging from hardware and software, to training of staff and development of tailored products and dissemination platforms.

Demand	Vietnam – there is a demand for better hydro-meteorology from a wide array of sectors, not only agriculture and DRM, but also tourism energy users. They want increasingly tailored applications for their needs. Vietnam – the adoption of the planned system at the time of writing was not 100 per cent complete within the Government; it is recognized as a crucial step to gain 100 per cent support and enhancement cooperation via the Government.

Other Key Points/Observations

This report is a detailed needs assessment and program strategy for improved hydro-meteorology services in Vietnam.

The prospects for improvements are noted across more than 10 sectors is outlined and discussed (including climate change, tourism, energy, building industry, agriculture, forestry, military, media, DRM etc.).

It is apparent that the planned investment program for Vietnam will begin to capture and create an increasingly robust data set of hydro-meteorological data and additional information. It appears the core of the program will go into the underpinning hardware, remote sensing infrastructure, software and training of people to capture manage and store the data. It appears on the surface that the development of the user application elements is not as yet strongly defined.

SERVIR-Mekong may have opportunity to work with, and support the design of user applications or tailored products for different sectors. This will require cooperation in the potential design and user applications and the various "media" to transmit and use those applications.

The report indicates that there may be a strong support role from Vietnam for Lao PDR and Cambodia for some 'base services' that the observation stations could provide across borders. This data and information sharing aspect could be a facilitation role of SERVIR-Mekong.

Appendix F. Relative Thematic Priorities: Detailed Data Compilation Table

This table is a detailed summary of the expression of priority GEOSS themes (e.g., major headings) and subtopics within those themes. Thematic sections are arranged in order of how frequently they were selected as top priorities in the region by contributors both to the consultations and the online questionnaire. The order of country columns is based on the relative number of contributors to both consultations and the online questionnaire. Since a detailed roundtable consultation was not conducted in Thailand, columns for these data have been omitted.

Rows below major GEOSS themes are topics raised as priorities by stakeholders. In some cases, topics appear under two themes, and in these cases they are given the same colour to indicate this duel listing.

Each country section presents frequencies with which contributors identified themes as general priorities for the application of geospatial data and technologies in the region. For each method (consultations and questionnaire), numbers under the “Raw” headings are raw frequencies of contributors indicating that theme as a priority, whereas numbers under the “Norm” headings have been transformed to a 100 point scale (e.g., the raw frequency for a GEOSS theme divided by the overall number of expressions of priority times 100); this has been done for easier computation and comparison of overall relative priorities between information source type and between countries. To calculate aggregate country scores, the assessment team used a weighted average where outcomes of consultations were given four times the weight of questionnaire responses in order to reflect the fact that the overall number of individuals expressing priorities in consultations was approximately four times that of the questionnaire response rate.

Regional relative priorities are simply an average of values for a given theme across all five countries.

	Vietnam					Cambodia					Myanmar					Lao PDR					Thailand			Lower Mekong Region Aggregate	Lower Mekong Region Rank
	Consultations		Questionnaire		Combined	Consultations		Questionnaire		Combined	Consultations		Questionnaire		Combined	Consultations		Questionnaire		Combined	Questionnaire		Combined		
GEOSS Theme/Subtopic	Raw	Norm	Raw	Norm		Raw	Raw	Norm	Raw		Raw	Norm	Raw	Norm		Raw	Norm	Raw	Norm		Raw	Norm			
Disasters	**18**	**35**	**16**	**28**	**33**	**17**	**31**	**9**	**25**	**30**	**13**	**30**	**10**	**36**	**31**	**9**	**26**	**12**	**43**	**30**	**12**	**39**	**39**	**32**	**1**
-General Disaster Risk Management (DRM)											2		1			5									
-Early warning systems (General)						4																			
-Drought forecasting	1					6					2														
-Flood forecasting	10					2					4														
-Forest Fire detection / early warning	1					2					1														
-Landslides risk assessment	1					2																			
-Extreme weather event forecasting																									
- Multi-hazard risk/exposure mapping																									
-RS Images/mapping for Emergency response											2					4									
-Mobile apps for disaster information dissemination																									
-Health information storage and dissemination						1					2														
-Dam integrity/safety	5																								
-Offshore fleet monitoring																									
Ecosystems	**16**	**31**	**6**	**10**	**27**	**22**	**40**	**3**	**8**	**34**	**15**	**34**	**3**	**11**	**29**	**12**	**35**	**1**	**4**	**29**	**2**	**6**	**6**	**25**	**2**
-Land cover/land use (change)	1					8					2		5			7									
-Forest cover	6					4					3					5									
-Mangroves						2					3														
-Riparian zone																									
-Degradation	6																								
-Urbanization	3					4					1														
-Environmental Impact Assessment						4					6														

	Vietnam					Cambodia					Myanmar					Lao PDR					Thailand			Lower Mekong Region Aggregate	Lower Mekong Region Rank
	Consultations		Questionnaire		Combined	Consultations	Questionnaire			Combined	Consultations		Questionnaire		Combined	Consultations		Questionnaire		Combined	Questionnaire		Combined		
GEOSS Theme/Subtopic	Raw	Norm	Raw	Norm		Raw	Raw	Norm	Raw		Raw	Norm	Raw	Norm		Raw	Norm	Raw	Norm		Raw	Norm			
-General environmental monitoring																									
Water (and hydrology)	**8**	**15**	**15**	**26**	**17**	**8**	**15**	**6**	**17**	**15**	**8**	**18**	**5**	**18**	**18**	**8**	**24**	**5**	**18**	**22**	**8**	**26**	**26**	**20**	**3**
-Understanding groundwater stocks and flows	3										2														
-General/Integrated water resources management						8										3									
-Understanding surface water stocks and flows	4										3														
-Understanding sediment stocks and flows	1															5									
-Understanding erosion																									
-Basin/watershed management											3		3												
Climate (Change)	**4**	**8**	**11**	**19**	**10**	**0**	**0**	**8**	**22**	**4**	**1**	**2**	**4**	**14**	**5**	**0**	**0**	**4**	**14**	**3**	**5**	**16**	**16**	**8**	**4**
-Sea level rise – coastal inundation/vulnerability	1										1														
-Saltwater intrusion																									
-Extreme weather event forecasting																									
-Urban vulnerability	3																								
Agriculture	**4**	**8**	**8**	**14**	**9**	**0**	**0**	**8**	**22**	**4**	**0**	**0**	**5**	**18**	**4**	**0**	**0**	**4**	**14**	**3**	**3**	**10**	**10**	**6**	**5**
-Distribution (coffee, rice etc.)																									
-General crop monitoring	2																								
-Yields (rice)	2												2												
-Aquaculture extent/distribution (e.g., shrimp, fish ponds)																									
-Pest impact																									
-Combatting desertification																									

	Vietnam					Cambodia					Myanmar					Lao PDR					Thailand			Lower Mekong Region Aggregate	Lower Mekong Region Rank
	Consultations		Questionnaire		Combined	Consultations	Questionnaire			Combined	Consultations		Questionnaire		Combined	Consultations		Questionnaire		Combined	Questionnaire		Combined		
GEOSS Theme/Subtopic	Raw	Norm	Raw	Norm		Raw	Raw	Norm	Raw		Raw	Norm	Raw	Norm		Raw	Norm	Raw	Norm		Raw	Norm			
Health	**0**	**0**	**1**	**2**	**0**	**3**	**5**	**1**	**3**	**5**	**5**	**11**	**1**	**4**	**10**	**0**	**0**	**1**	**4**	**1**	**1**	**3**	**3**	**4**	**6**
-Air quality						1					3														
-Pesticides						1																			
-Toxins (arsenic)											1														
-Health information storage and dissemination						1					1														
-Power Plants																									
-Landmines																									
-Marine fisheries monitoring																									
Weather (and Meteorology)	**0**	**0**			**0**	**5**	**9**			**7**	**0**	**0**			**0**	**4**	**12**			**9**			**0**	**3**	**7**
-Hydro-meteorology data						3										4									
-Generally improved weather forecasting						2																			
-Real-time water resource status monitoring																									
-Improved SWAT model capacity																									
Biodiversity	**0**	**0**	**1**	**2**	**0**	**0**	**0**	**1**	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**4**	**1**	**0**	**0**	**0**	**0**	**8**
-Biodiversity management																									
Miscellaneous	**2**	**4**			**3**	**0**	**0**			**0**	**2**	**5**			**4**	**1**	**3**			**2**			**0**	**2**	**N/A**
Sub-regional planning	2																								
Mapping Infrastructure																1									
Monitoring human migration											1														
Irrigation (efficiency)																									
Policy/program impact monitoring																									

	Vietnam					Cambodia					Myanmar					Lao PDR					Thailand			Lower Mekong Region Aggregate	Lower Mekong Region Rank
	Consultations		Questionnaire		Combined	Consultations		Questionnaire		Combined	Consultations		Questionnaire		Combined	Consultations		Questionnaire		Combined	Questionnaire		Combined		
GEOSS Theme/Subtopic	Raw	Norm	Raw	Norm		Raw	Raw	Norm	Raw		Raw	Norm	Raw	Norm		Raw	Norm	Raw	Norm		Raw	Norm			
Crowd-sourcing tool for participatory mapping											1														

Asian Disaster Preparedness Center
SM Tower, 24th Floor
979/69 Paholyothin Road,
Samsen Nai Phayathai,
Bangkok 10400, Thailand