

**MEKONG- HYCOS PROJECT**  
**A HYDROLOGICAL INFORMATION SYSTEM TO IMPROVE SHORT AND**  
**MEDIUM TERM FLOOD FORECASTING IN THE MEKONG RIVER BASIN**

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**1. ABSTRACT**

The Mekong River is marked, on the one hand, by an important under-utilization of its vast water resources potential, and on the other by frequent large magnitude flooding that causes widespread damages and devastation. In order to assist the Lower Mekong Basin (LMB) countries in addressing the abovementioned development issues, a proposal was made in 2003 for the development and implementation of a comprehensive Hydrological Information System for the Mekong River Basin (Mekong-HYCOS), with the concept of the World Hydrological Cycle Observing System (WHYCOS) of the World Meteorological Organization (WMO) chosen for consideration as a base. The project would envisage strengthening the aims and objectives of the minimize the loss of lives and property by reducing flood vulnerability in the Mekong River Basin, through strengthening integrated water resources management in the context of trans-boundary river basin management. It also considers what other information services the system could provide for: a) water resources development and management; and b) other activities with a strong hydro-meteorological component. The Implementation of the project has been started in January 2007.

**2. INTRODUCTION**

Flooding of the Mekong River is a recurrent event, which affects the whole Basin. Almost every year, it takes away hundreds of lives and causes damage to infrastructure, agricultural and industrial production and severely affecting socio-economic development. Recurring floods of the magnitude and frequency observed in the region are an important impediment to a more rapid development in the Mekong basin. However, flooding of the Mekong is also an important source for the wealth in bio-diversity, abundance of fish, and soil fertility in the Mekong River Basin. Positive and adverse effects of floods need to be balanced. In the year 2000 a particularly devastating flood occurred in the Lower Mekong Basin. It caused damage of US\$ 400 Million, and 800 fatalities, mainly children. It recognises the importance of flood management and mitigation in the Mekong river basin. Particular emphasis is placed on the improvement of the flood forecasting and warning system involving the establishment of the Mekong Hydrological Cycle Observing System (Mekong-HYCOS) which consists in establishing an efficient, reliable and accurate timely hydro-meteorological data collection and transmission system at basin level, while also strengthening relevant national and regional capacities. This information will be shared between the MRC Member States: Cambodia, Lao PDR, Thailand and Viet Nam. Map 1. is shown the location of Mekong-HYCOS Project.

The Mekong-HYCOS project will establish a basin wide hydro-meteorological information system, which spatially covers mainstream and main tributaries of the Mekong river system. It is expected that under the Mekong-HYCOS project, more than 20 hydro-meteorological stations will be upgraded. The Mekong-HYCOS system will be integrated into the existing

MRC monitoring system, while improving the national hydrological networks and river monitoring/forecasting capacities.

The MRC Member States are responsible for flood forecasting within their own territory and committed to share relevant data and information in the framework of Mekong-HYCOS.

The project is planned from 2007 to 2011 with 3 main steps:

- the Inception Phase that will last approximately 12 months: project conception, tendering and ordering process for hydro-meteorological stations (equipment, telemetry system, civil work);
- the Construction Phase. It is anticipated to last no more than 6 months;
- follow-up of the system, during approx 3.5 years in order to assure proper maintenance and training to the local staff and therefore to make the project more sustainable.

### 3. PROBLEM ANALYSIS

Presently almost 60 million people are living in the Lower Mekong Basin; of these roughly 30 million people live in the flood plain, During the flood of 2000 some 10 million people were displaced of which 8,5 million from Cambodia and Vietnam alone.

The flood patterns in this region are very different with respect to causes, sources of flooding and effects, rising speed, time and duration of flooding, frequency and extension of the inundated area. There are, furthermore, local variations within each country, mainly due to differences in natural conditions, man-made structural measures and other human activities.

Lao PDR suffers from floods nearly every year. Floods generally occur as a result of a combination of high rainfall due to typhoons and the occurrence of the southwest monsoon. The combined effects of the resulting large flows from tributaries and, at the same time, the main river, cause serious damage. A feature of floods in Lao PDR is that they are very much influenced by tributary flows. According to MRC estimates, tributaries cause 80% of the rural flooding and 20% of the urban flooding. Consequently, the four major flood prone areas are situated along the main stream near large tributaries: (i) Vientiane Plain, (ii) Khammoune Province (Thakhek town), (iii) Savannakhet Province and (iv) Champasak Province (Pakse town). Peak flood in year 1966 and flash flooding during the first week of October 2006 associated with Severe Tropical Storm Xangsane are depicted in Figure 1 and Figure 2 respectively.



Figure 1.

Vientiane Capital, September 1966, Central Area under water for 5 weeks, Flood peak=26,000 m<sup>3</sup> (approximately a 1 in 100 year event)



Figure 2.

Attapeu province, Lao PDR—flash flooding during the first week of October 2006 associated with Severe Tropical Storm Xangsane.

In the Mekong River Basin part of Thailand, flooding results from tropical disturbances, typhoons, or a combination of the two. The heavy rainfall on the Lao side swells the Mekong River, which at places bursts its banks or, by backwater effects, creates severe flood conditions in the basins of tributaries. In recent years, three high floods in the Mekong River Basin have affected Thailand, with widespread inundation of productive lands and settlements that caused remarkable damage and suffering for people. Mid–August floods in Nan Province, Thailand caused many families to retreat to the upper floors of their houses is shown in Figure 3-4.



Figure 3-4  
Mid–August floods in Nan Province, Thailand caused many families to retreat to the upper floors of their houses.

In Cambodia, the Mekong enters into the low part of the delta and becomes a slow flowing river with a major bifurcation. The area is very flat, and flooding is generally related to the main river system. When flooding occurs, it often covers large areas of Cambodia. The dynamic river junction at Phnom Penh, where the Mekong bifurcates in the Bassac and the Lower Mekong and where the Tonle Sap River starts, is also an indication of the flatness of the land and of the complexity of the river system. Flooding is not only attributable to the Mekong, but also partly to backwater effects from the Tonle Sap River and Lake system. Each year up to 4 million ha of lowland areas are inundated. In some areas along the river, regulating structures have been built on tributaries, allowing farmers for a short period of time to control inflow from the raising rivers to the low land areas.

In Viet Nam the Mekong River forms a highly fertile and productive delta, which is heavily influenced by tidal effects from the South China Sea, high discharge from the Mekong River coming from upstream Cambodia, and heavy rain in the delta itself that comes with the monsoon and typhoons originating over the South China Sea. Flooding in the delta often results in an almost complete inundation of the flood plain. Up to a certain flood level, people living in the area have come to get adapted to the situation. Viet Nam has considerable experience in regulating structures that allow for longer agricultural use during the year.



Although these structures hold back the floodwaters in some areas during the early floods, the high floods still cause enormous damage. Flooding during August and September 2006 in the lower Delta (Dong Thap province) and severe flood over Lower Mekong River Basin are shown in Figure 5 and Figure 6 respectively.

In April 2002, participants to the First Annual Mekong Flood Forum (Phnom Penh, Cambodia), agreed upon the following lessons learned from the exceptional year 2000 and 2001 floods in the Lower Mekong River Basin:

- a) lack of timely flood forecasting;
- b) deficient flood forecasting models;
- c) poor hydrometric measurement network;
- d) difficulty to obtain high quality data.

Furthermore, the representatives of MRC Member States and participants to the MRC International Expert Meeting on Early Warning for the Mekong River (Phnom Penh, Cambodia, March 2002), agreed on the following needs:

- a) improvement of the hydro-meteorological database (including data bank development, rainfall and weather data, and terrain data);
- b) improvement of the modelling base for both flash floods on tributaries, and slower floods on the Mekong main stem. The meeting also advised to strengthen the links between the MRC and the national weather services (and other line agencies) of the Mekong countries, as well as with international organizations, in particular WMO and including the joint UN- ESCAP/WMO Typhoon Committee.



Figure 5.  
Flooding during August  
and September 2006 in the Lower Mekong Delta  
(Dong Thap province, Viet Nam).



Figure 6.  
Severe flood in the Lower Mekong River Basin  
In Viet Nam

While weather forecasting systems have reached a high level of accuracy, and weather data and forecast products are shared on a regional and global basis, there are at present insufficient regional mechanism for the regular exchange of hydrological data and information in the Mekong River Basin. Reliable hydrological databases and efficient hydrological information systems, coupled with national, regional, and global weather forecasting systems are

indispensable to forecast floods and mitigate their devastating effects.

There has been some success in the sharing of historical data, and bilateral agreements between countries in the Mekong region have proven useful in river monitoring and forecasting. However, in the regional context, achievements with regard to the sharing of real time data and information on a regional scale, which is so critical for an integrated regional perspective of river monitoring and forecasting, requires up scaling and improvement.

In several countries of the region, the quantity and quality of collected hydrological data is at present not sufficient for effective river monitoring and forecasting even at national level, nor is it for optimal river basin development and integrated water resources management in a broader sense. Quality problems include long observation gaps in time series (particularly during extreme events such as floods and droughts), inaccuracy and lack of standardisation in measurements and data transmission systems. Appropriate training approaches and institutions that can ensure the transferred technology should be permanently sustained in the region.

#### **4. PRINCIPLE OF THE MEKONG- HYCOS PROJECT**

The basic principle of the project is to collaborate with the different countries in a regional context and in a manner, which is based on the objectives of the MRC Strategy.

The Mekong- HYCOS project will support the national and regional implementation of the FMMP as well as the other programmes as the multi-functional project. The actual MRC automatic stations and flood forecasting system are mainly located along the main stem of the Mekong. Complementary to this, the Mekong-HYCOS project will establish a regional hydro-meteorological information system, which spatially covers mainstream and main tributaries of the Mekong in the MRC Member States.

The backbone of the system is a network of hydrological and meteorological stations which provide real time data to be primarily used for river monitoring and forecasting and products to be developed for flood forecasting. In this way, the information can be directly used by authorities that are responsible for the transmission of flood warnings and the MRC to enable the provision of regional flood warnings and data required by the programmes activities. A principle of data flow is given in Figure 9.

The Mekong-HYCOS would complement activities of the MRC with regard to the Appropriate Hydrological Network Improvement Project (AHNIP), which is currently operated by the MRC for stations on the mainstream, in order to constitute the MRC Network. Potential linkage between the existing MRC telemetry systems, the Mekong-HYCOS and current system between WMO and line agencies will be considered to ensure efficiency, effectiveness and synergy of data flow.

#### **5. LESSONS LEARNED FROM OTHER HYCOS PROJECTS AND PREVIOUS MRC PROGRAMME**

The experience gained during the implementation of the existing projects and the many contacts made with different stakeholders while developing new HYCOS components have provided a number of lessons which have led to the introduction of some adjustments in the development of WHYCOS and AHNIP project, especially with regard to aspects of ownership,

sustainability, and the funding of projects.

➤ **Ownership of the project by the NHSs**

The role of the Regional Centre (RC) is indeed crucial for the success of any HYCOS project. Besides creating and maintaining the regional spirit of co-operation within the project, the RC is responsible of the management and update of the regional database and of the operation of the internet server of the project. Nevertheless, it has to be recalled that the essential baseline activities, such as the collection of hydrological data in the field, the operation and maintenance of the observational network, quality control and the primary processing of the data, depend entirely on an in-depth and continuous involvement of the NHSs of the participating countries. The commitment of these services to the project must be firm and persistent. Thus the project must provide them with access to regional information which truly relevant at national level. This includes the status of water resources storage and uses along trans-boundary rivers and timely information on water-related disasters such as floods, extreme low-flows and accidental pollution concerning these trans-boundary waterways. Experience has shown that the sole membership of a country to a large common socio-economic or politico-economic region has not always been sufficient for creating the required sense of ownership on hydrological matters among participants. This is because the "regions" or even the "sub-regions" are very large and heterogeneous units, and their member countries may show very different profiles regarding water resources issues. On the other hand, the upstream-downstream situation along a trans-boundary river course is certainly a very efficient configuration for creating interest and a sense of ownership among the participating countries and this criterion should certainly be privileged when developing new HYCOS projects.

➤ **Sustainability, operation and maintenance of HYCOS Projects**

Regarding and funding and financial problems face by developing countries, it was pointed out that the difficult to convince government and funding agencies of the importance of obtaining data from HYCOS projects. Further, some countries commit themselves for operation and maintenance but eventually find out that they cannot afford it. During first Regional Workshop in July 2007, only Vietnam already suggested 1 year delay for its national contribution for Operation and maintenance, starting from 2010 instead of 2009 as Mekong-HYCOS workplan. Other three countries agreed in principle but need to consider the national budget. It is likely to be difficult for them to commit to support financially to phase-out plan, esp. for Cambodia and Lao PDR.

➤ **Training and Capacity Development under AHNIP project**

Training and capacity building is the primary focus underlying AHNIP, not equipment technology. In following this focus, the project has developed an MRC Accredited Technical Training system, and has developed a cohort of technical Trainers in the riparian countries. Capacity development under AHNIP project should be applied and implemented by Mekong-HYCOS with a three-pronged approach targeting respectively selection of trainees, translation and proposed number of trainees

**Selection of Trainees** – AHNIP found that the counterparts have limited experience in selecting suitable training candidates with the skills and experience background, and the correct type of role in their department, to usefully participate in training courses.

A specific effort was required by the AHNIP project team therefore, to assist the counterparts select suitable trainees which included a process of assessment against detailed selection criteria.

**Translation** – Although English is the official language of the MRCS, it is not so in the line agencies on whom the day-to-day operation depends. AHNIP found that most line agency staff who were otherwise ideal candidates for training, did not have sufficient skill in English to benefit from training in that language. Conversely, people skilled in English often did not hold the correct role in their department, or have the necessary technical background to be suitable training candidates. These people were used to deliver our training to their compatriots, in the native language, under the guidance of project staff.

**Proposed number of trainees** – AHNIP fully support the number of trainees planned for training in Mekong-HYCOS. The AHNIP project was asked to spread the training and capacity building efforts widely in recognition of the fact that the project was supposed to be building a capacity that would be applied to other monitoring stations and equipment besides the AHNIP stations. In the end however, the benefits were diluted as a result. The AHNIP capacity building efforts would probably have been more effective if reduced in scale, but more specifically targeted to about the number of trainees that Mekong-HYCOS is planning.

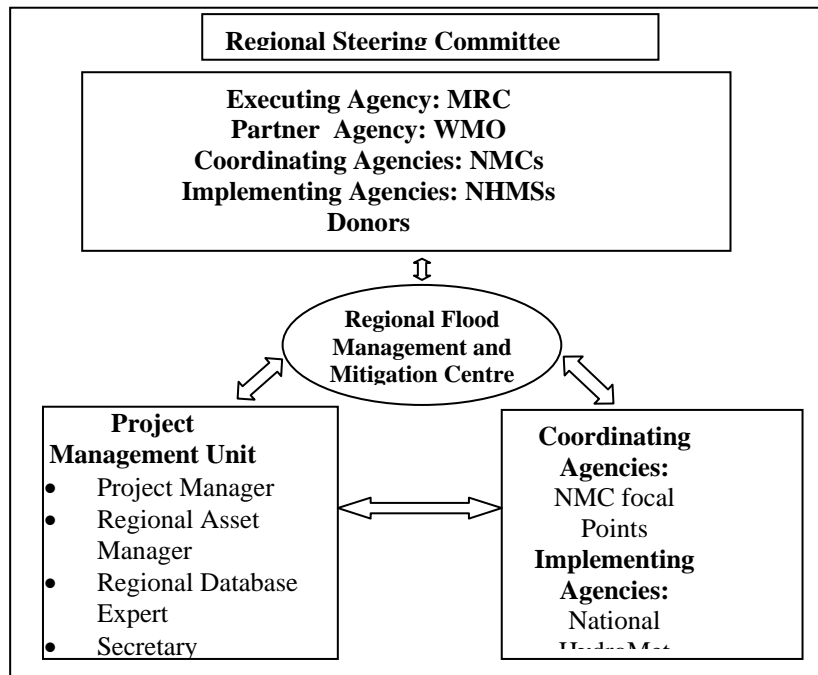
#### ➤ **Funding of HYCOS Projects**

Many of the planned HYCOS projects cover very large areas and may involve a large number of countries for periods of five years or more. Thus, the estimated costs of the projects are quite high and this can become a problem for a single donor. Consequently, it is necessary to pool the contributions of several donors and funding agencies (international, regional and bilateral). As the origin of funding sources increases, a number of constraints arise: it becomes difficult to synchronise all contributions with the expected launching date of the project, the technical and financial regulations (i.e., application rules, eligibility of countries to grants, tendering procedures, etc.) may vary substantially among donors. Furthermore, for evaluating the effectiveness of their contribution, some donors prefer to fund an identified stand-alone sub-component rather than to contribute in a non-differentiated manner to the support of a large project. These considerations also strongly support the idea of implementing WHYCOS in the form of components geographically less extensive than the politico-economic regions or sub-regions.

## **6. PROJECT ORGANIZATION AND IMPLEMENTATION**

The organization of the project is based on the active implication and participation of the MRC member countries (Cambodia, Lao PDR, Thailand and Vietnam). These countries indeed have a major role to play since they are owners of the measurement stations and responsible for their upkeep and maintenance. They play an essential role in piloting the project within the Regional Steering Committee, and they shall obviously be the first to benefit from the project.

Day-to-day management of the project is delegated to MRCS through the Project Management Unit. The team of international consultants shall also play a major role of technical assistance and training of the teams of experts and both regional and national operators.



### Project Governance and Management

The project implementation carried out in close collaboration with the national line agencies of the countries would last a total of 5 years.

It can be categorized into three main steps:

- the Inception Phase that will last approximately 12 months: During that stage, the proposed hydro-meteorological stations will be visited by appropriate experts, civil work designed/started, and a list of Hydro-meteorological equipment and Telemetry system finalized and ordered. Proper schedule would be set for the following project implementation stage;
- the equipment installation stage would continue with the construction of civil work and installation of the hydrometric and telemetry equipment. It is anticipated to last no more than 6 months;
- the last stage will be mainly devoted to the follow-up of the system, during approx 3.5 years in order to assure proper maintenance and training to the local staff and therefore to make the project more sustainable.

### Field visits

In March-April 2007 the Project Management Unit and Consultants (CNR/IRD) accompanied by line agencies and National Mekong Committees visited more than 40 hydro-meteorological stations. Ranking for improvement of stations depending on location, relevance for flood forecasting has been defined during the National Consultations and first Regional Workshop held in July 2007. Hydro-meteorological equipment (rainfall and water level), telemetry system and civil work have to be designed and approved by countries. MoUs between MRC and countries for Ownership and Operation and Maintenance will be signed before the Construction phase. Map-2 showing the proposed stations to be upgraded by Mekong-HYCOS.



Mekong-HYCOS Field visit team in Duc Xuyen station, Viet Nam, and Muang Ngoy, Nam Ou river, Lao PDR, March 2007 are given in Figure 7 and 8 respectively.

In the framework of Mekong-HYCOS project and for the MRC Hydro-meteorological Network, It was decided to upgrade 22 stations in the Priority 1. Complementary, these stations, for a better knowledge of the tributaries of the Mekong River, and according with the project budget, it is planned the possibility to add a maximum of 14 other stations as Priority 2. Other financial resources are currently mobilised to upgrade a measuring network along the Mekong River with a total number of 15 stations under Appropriate Hydrological Network Improvement Project (AHNIP). These stations would be modernized at later stage in order to harmonize the whole of the MRC hydrological network.



Figure 7.  
MEKONG- HYCOS team in Duc Xuyen  
station (Viet Nam), March 2007



Figure 8.  
MEKONG- HYCOS team in Muang  
Ngoy, Nam Ou river  
(Lao PDR), March 2007

## 7. KEY STEPS IN ESTABLISHING A MEKONG- HYCOS PROJECT

- a) Reaching agreement among participating countries to proceed with establishing a HYCOS. This is an essential first step, to ensure that there is joint commitment to the concept and that the system will be maintained into the future.
- b) Define the set of objectives that are to be met. These include, in general, the information required to underpin sustainable economic and social development in the participating countries, to provide sound information for the sharing of water in trans-boundary river basins, to warn of and protect from water-related disasters and to provide the international community with hydrological data to support global water resource assessments and hydrological/environmental science.
- c) Enhance the existing field data collection systems and install new ones as required. WHYCOS has favoured real-time data collection systems based on the constellation of meteorological geo-stationary satellites such as GOESs, METEOSAT, among others.
- d) Upgrade national data processing and archiving systems. The implementation of a HYCOS project provides a vehicle for installing new equipment for archiving and retrieving data,

introducing refined data processing and quality assurance procedures, and providing appropriate staff training. Existing facilities are used as a starting point, but are strengthened and extended as necessary.

- e) Establish distributed regional databases, designed to provide data of defined, consistent quality which are regularly updated and available to users in a timely manner. The existence of distributed regional databases, while providing support for individual countries, is a key feature for a more efficient handling and sharing of information on trans-boundary water bodies.
- f) Establish a regional telecommunications network on water resources information, designed to exchange messages, verified data and information via email and electronic file and document transmission.
- g) Staff training. Training on the use of the newly introduced technology is essential, but the opportunity is also taken to provide refresher training in more conventional hydrological skills, as well as in non-technical areas such as administration, public relations and customer service.
- h) Performance monitoring and follow-up. To avoid the difficulties that in the past have been commonly experienced in capacity building programmes, careful monitoring of performance against defined objectives is maintained. This provides the ability to identify impediments to successful implementation, and their removal, thus assuring long-term sustainability of the HYCOS projects.

## **8. CONCLUSIONS**

It is concluded that the Mekong-HYCOS project be developed as a regional component of the global WHYCOS programme. Thus, it will have a number of common features with other regional components such as, for example, the methodologies to obtain real-time hydrological observations and the establishment of a regional hydro-meteorological information system that will be accessible to all participating countries. Hydrological data and related information will be observed at specific sites and transmitted in real-time via meteorological satellite and/or other means of telecommunication to the National Hydrological Services to be used for forecasting and monitoring purposes. The observations will be transmitted simultaneously to a Regional Data Terminal for inclusion in the regional database. Finally, the regional hydro-meteorological information system is intended to provide a continuously updated picture of the regional water resources and hydrological situations.

In addition, the strong link and integration of all MRC hydrometeorological related activities, particularly between AHNIP and Mekong HYCOS, will expand and strengthen the Mekong network as a whole to meet highly demanding requirements for timely data for flood/drought forecasting and river monitoring, water utilization and management, transboundary environmental assessment, modelling, etc.

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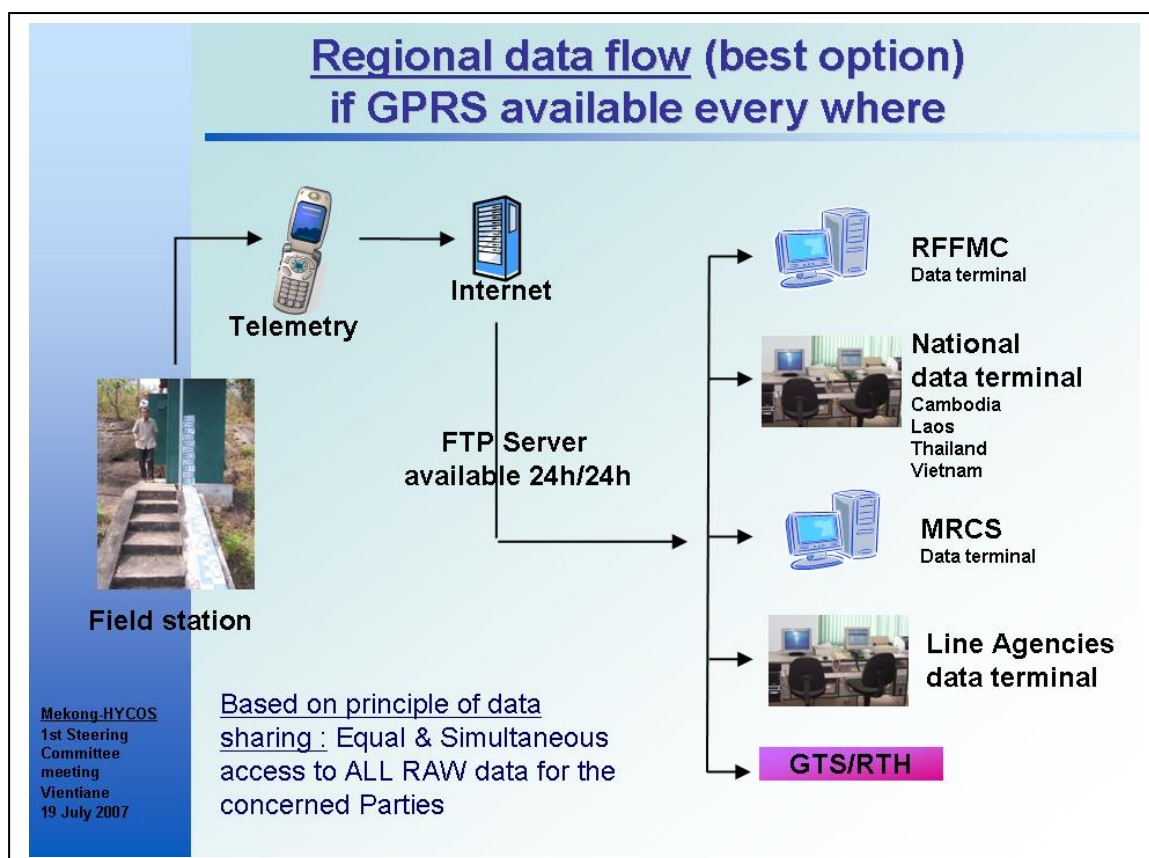
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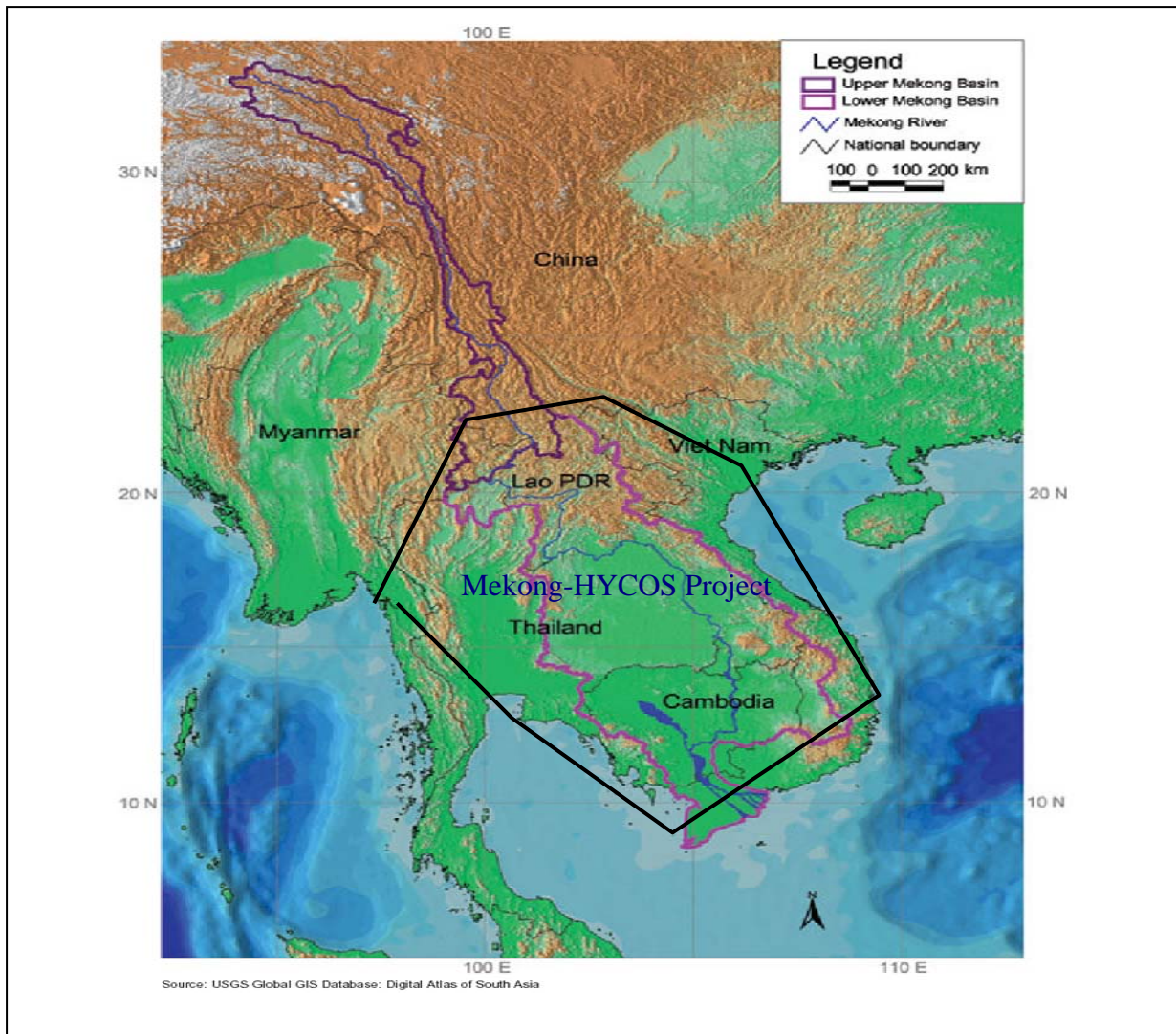
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Figure 9-The principle of Mekong-HYCOS data flow





MAP 1-Location of Mekong HYCOS Project



MAP 2-PROPOSED STATIONS TO BE UPGRADED BY MEKONG\_HYCOS

