Ministry of Public Works and Transport
Project Management Unit 3

Climate Resilience for Provincial Road Improvement Project
Loan 2839-CAM (SF)/ 8254-CAM and Grant 0278-CAM

REPORT ON KNOWLEDGE MANAGEMENT

Prepared for the
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egis
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Important note

This report is still in progress and will be updated as final training activities are conducted.

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Abbreviation

ADB	:	Asian Development Bank
CIF	:	Climate Investment Fund
CTF	:	Clean Technology Fund
DGPS	:	Differential Global Positioning System
FIP	:	Forest Investment Program
FRMI	:	Flood Risk Management Interface
GIS	:	Geographic Information System
KM	:	Knowledge Management
PMU3	:	Project Management Unit 3
PPCR	:	Pilot Program for Climate Resilience
PRIP	:	Provincial Roads Improvement Project
SCF	:	Strategic Climate Fund
SPCR	:	Strategic Program for Climate Resilience
SREP	:	Scale Up Renewable Energy Project

1 BACKGROUND

Cambodia is one of the pilot countries participating in the Pilot Program for Climate Resilience (PPCR). The PPCR provides incentives for scaled-up action and transformational change in integrating consideration of climate risks and resilience in national development planning, consistent with poverty reduction and sustainable development goals. The priority sectors for PPCR in Cambodia include water resources, agriculture and infrastructure. In June 2011, the PPCR sub-committee endorsed Cambodia's Strategic Program for Climate Resilience (SPCR) with a funding envelope of up to $86 million ($50 million in grants and up to $36 million in concessional credit). Of this, an allocation of $17 million ($10 million loan and $7 million grant) was endorsed for "Climate-proofing of Roads in Prey Veng, Svay Rieng, Kampong Chhnang and Kampong Speu Provinces" Output as part of the ADB-funded "Provincial Roads Improvement Project" (i.e. CR-PRIP).

The CR-PRIP addresses the need for greater integration between sectors (transport, water, and environment) and includes for **Knowledge Management** to be provided to Governmental and local administration. Knowledge management is however a generic term that comprises a large number of activities. In view of the capacity observed at national and local levels and of the type of technical assistance provided, this management has therefore been focused on:

- New knowledge and skills acquisition
- Refreshing existing knowledge
- Improving knowledge access, dissemination and conservation, and
- Minimizing losses of knowledge and skills through time

New knowledge and skills acquisition as well as refreshing existing knowledge has been carried out in the form of training, workshops and public consultation. New knowledge acquisition is strongly oriented toward the piloting of new technology, software and methods as per the nature of the technical assistance. 17 climate resilience related training/workshop events have been designed and delivered. Within a total of 15 months of project implementation[1], more than 454 candidates participated in these events.

The improvement of access to knowledge, to its dissemination and its conservation was addressed by the development of a knowledge management tool called Flood risk management interface (FRMI). This software provides easy access to information about floods and roads, as well as flood risk maps developed under the CR-PRIP.

The need to minimize losses in knowledge is answered by linking the Output training activities to work processes in the Ministry, by recommendations for setting up a continuous training program and by recommendations on the setup of a permanent climate change unit in the Ministry.

2 TRAINING ACTIVITIES

2.1 Training aims and formulation process

The training activities broadly consisted of on-the-job training / mentoring, small group training sessions and larger workshops. These activities were developed early following a general diagnostic that although pockets of flood proofing knowledge and skills were found in the organization, few specialists had a comprehensive view of all the tasks required to efficiently plan and design climate resilient infrastructures. Similarly, awareness of climate change was found to be insufficient in the field in order for the communities to understand and participate in the MPWT activities. Finally, several obstacles and constraints were encountered in the collection of climate and geography related data in the Cambodian Ministries.

Therefore the training activities were devised to:

- To inform and increase awareness of climate change / flooding impacts
- To create a new group of infrastructure flood proofing practitioners
- To promote inter-department, inter-ministerial and national-local information exchange

For all training courses except hardware training, training material was prepared and delivered by individual experts. The proposed training material is first be sent to Project Management Unit 3 (PMU3) for approval. Within this period of time, a consultation with the project manager or project director is

[1] From the start of the project (March 2014) until the date of this report is written (June 2015)

conducted to select the candidates for the training. Training participants mostly came from PMU3 office but also from other agencies and the procedure for invitations is as follows:

- Participants from PMU3: project manager/director appoints his staff to attend the training directly. No formal letter from the output is required.
- Participants from other agencies: Other than PMU3 staff, including MPWT staff, a formal training invitation letter is sent out from PMU3. The respective agencies appoint their staff to come and participate in the training. For staff who come from the provinces to participate in the workshop, food and accommodation plus per diem is provided.

2.2 Training classification and courses

In total, 17 training sessions took place since the Climate Resilience output came into place. That training was classified as follows:

- Introducing new pilot technology (equipment)
- Introducing new pilot software
- Introducing new pilot methods and standards
- Strengthening scientific knowledge
- Awareness raising

All the training courses can be related to work processes developed for flood proofing roads and infrastructures as shown in Appendix 1.

Introducing new pilot technology (equipment)

Unmanned Aerial System or simply called drone, is a newly developed technology and it is very new to Cambodia. This drone enables the surveyors to carry out very precise maps using photographs from the sky. It is quite a challenge to introduce this new technology in the country but it worth a try since it has great potential to do many map-related work effectively and efficiently.

Even though TOTAL Stations, Digital level and DGPS are traditional tools, their latest versions bring much innovation and offer higher ease of use and better accuracy in conducting surveys. These machines enable surveyors to work much faster and more accurately at map making.

Introducing new pilot software

These software consist of map-making, flood simulation and road design software that enable practitioners to produce accurate maps and predicts flood at certain location under certain weather condition. They are critical for accounting for flood in road planning, management and budgeting. The role of this software in the flood proofing process is shown in Appendix 1.

Introducing new pilot methods and standards

Methods proposed by the Consultant for flood proofing roads include new planning, analyses and road design approaches, devised for streamlining the whole process. The main information analysis and management tool developed during the CR-PRIP, the Flood Risk Management Interface is presented in Chapter 4.

Strengthening scientific knowledge

The basic approach in improving the resilience of road to climate impacts is to look at the current design concept and make change in such a way that it enables road to stay dry and open for traffic at all seasons, i.e. flood proofed. This involves many scientific knowledge fields. The training program covered all the essential road design aspects such as culvert, embankment as well as the hydrology & hydraulic concepts.

Awareness raising

Awareness raising is key to bring adequate information to local communities in order to enable them to understand and participate into decisions related to climate resilience improvement initiatives, particularly those who affect their daily lives.

The list of the courses and their main objective is given below:

Table 1 List of courses and objectives

Objectives	No.	Course Name
Introducing new pilot technology	13	Survey Equipment (TOTAL Station + Digital level)
	14	Differential Ground Positioning System (DGPS)

Objectives	No.	Course Name
	15	Unmanned Aerial System including vehicle (Drone)
Introducing new pilot software	10	Flood modeling with global mapper
	11	Hydraulic design with culvert master and HY8
	8	Road Flood Proofing Tool selection
Introducing new methods, standards and reference tools	12	Flood risk management interface
	3	Vulnerability Mapping to Increase Climate Resilience
	16	Flood Risk Management Interface
	17	Climate Resilience Seminar
Strengthening scientific knowledge	1	Introduction to QGIS Training Course
	2	Culvert Design
	4	Geo-Referencing
	5	Embankment protection design
	6	Advanced QGIS
	9	Hydrology and Hydraulic concept
Awareness raising	7	Social Mapping Consultation for Community Vulnerability Assessment in Kampong Leaeng district

All training was delivered by CR-PRIP team experts except for equipment operation training which was carried out by the supplier to train participants on how to use the newly purchased tool or equipment.

The training included both outdoor and indoor activities. The indoor ones took place in the PMU3 training room where command, instruction and software were provided. Outdoor activity is where participants take turn practice on how to use the equipment or tool. In total 20% of the training time was spent outdoor and 3 training sessions on hardware took place over the course of the 15 months output period.

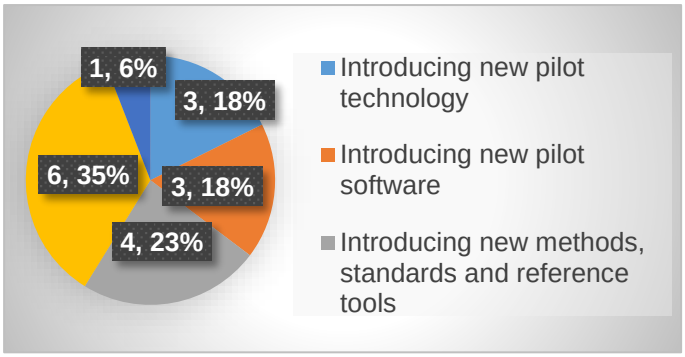


Figure 1 Percentage of training events per aim

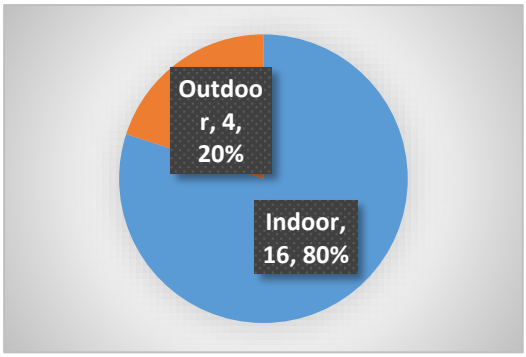


Figure 2 Training locations

2.3 Scope of attendance and participant profiles

A total of 454 candidates participated in 17 training sessions conducted over about 22 days scattered between July 2014 to June 2015. In total, 554 person days completed the courses. They came from 10 agencies/ministries, of which 19% of them came from the provinces.

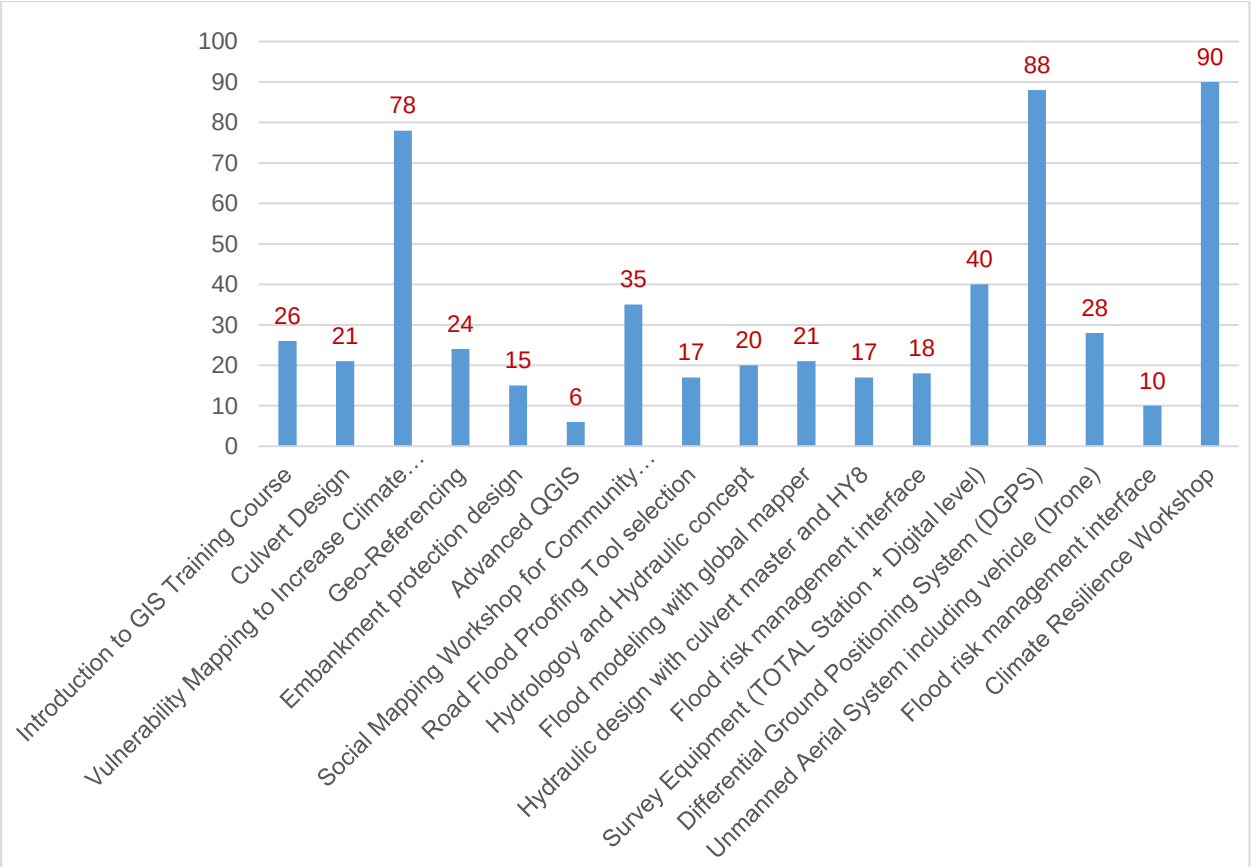


Figure 3 Number of participants in person days by course

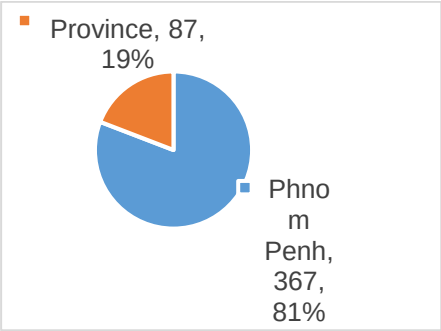


Figure 4 Participants workplace

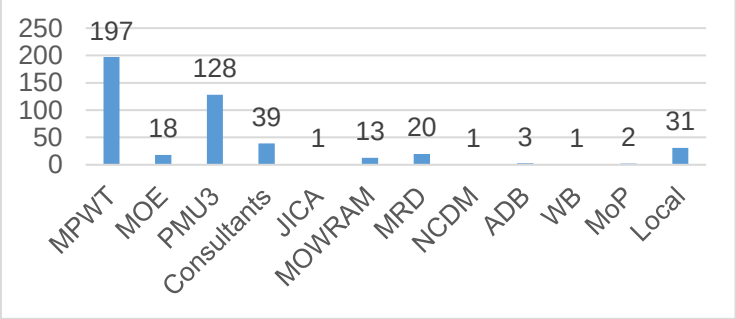


Figure 5 Agencies whose staff participated in the training

The ratio of National to Local participants corresponds relatively well to the type of topics offered, which focused primarily on new planning methods for flood proofing, on design standards and on the piloting of new technology and software, which must be introduced and appropriated first at the national level before being implemented at local levels.

Gender

PMU3 as well as CR team wished to see a higher number of women participating in the training events. However, with the appointment of training candidate solely under MPWT administration, only 25 female candidates or 6% of the total showed up in the training activities.

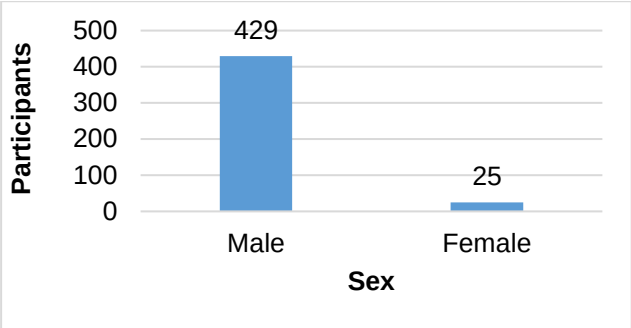


Figure 6 Scope of attendance by Gender

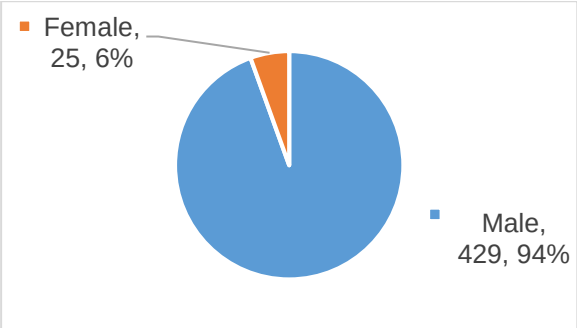


Figure 7 Gender ratio

2.4 Training schedule

After 4 months of preparation, data collection, analysis and administrative setup, the first training started in July 2014. Up until the end of December 2014, 370 candidates or 67% had been trained and by within two months period. Until June 2015 another 184 candidate or 33% had sit in the training room. From July 2014 until June 2015, training sessions took place every month except one month in 2014 (September) and two months in 2015 (March and May).

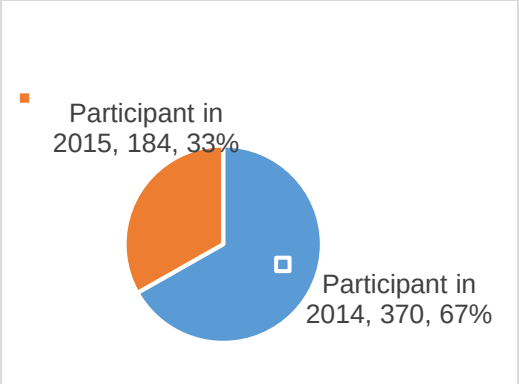


Figure 8 Number of participants by year

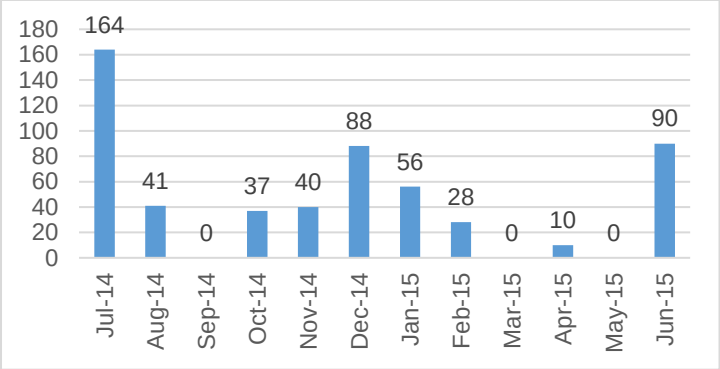


Figure 9 Number of participants by month

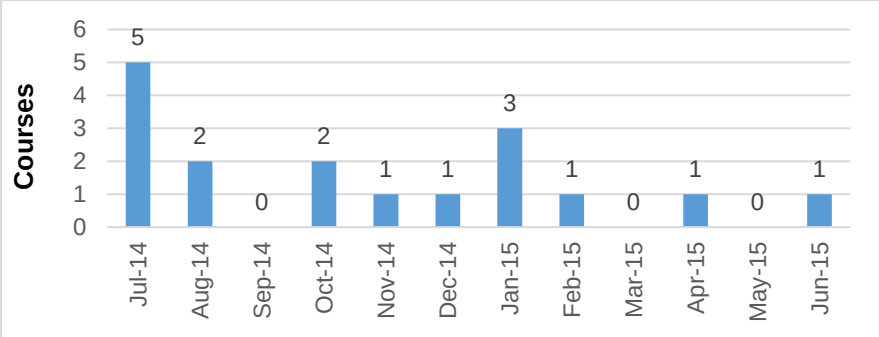


Figure 10 Number of training courses by month

The dates of each event have been compiled in a table in Appendix 2.

2.5 Knowledge improvement results

The improvement of knowledge was measured through two indicators, the participation to training activities and the satisfaction of the trainees in regard to the new skills acquired.

2.5.1 Invitation and participation

Before the start of any training session, invitations were sent and participants were appointed by their respective agency or office. In general, out of these 17 training and workshop, 97% of the total invitees showed up for training. The lowest turnout of invitees was for courses No. 12 (59%) and the most popular

event was No.17 (110%). The training was particularly popular among MPWT staff who knew about the assistance work going on in climate resilience and who had high interest to gain new knowledge.

Table 2 Participation

No.	Course Name	Invite	Participants	Participants %
1	Introduction to GIS Training Course	26	26	100%
2	Culvert Design	21	21	100%
3	Vulnerability Mapping to Increase Climate Resilience	78	78	100%
4	Geo-Referencing	24	24	100%
5	Embankment protection design	15	15	100%
6	Advanced QGIS	6	6	100%
7	Social Mapping Workshop for Community Vulnerability Assessment in Kampong Leaeng district	35	35	100%
8	Road Flood Proofing Tool selection	21	17	81%
9	Hydrology and Hydraulic concept	21	20	95%
10	Flood modeling with global mapper	21	21	100%
11	Hydraulic design with culvert master and HY8	21	17	81%
12	Flood risk management interface	26	18	69%
13	Survey Equipment (TOTAL Station + Digital level)	19	20	105%
14	Differential Ground Positioning System (DGPS)	21	22	105%
15	Unmanned Aerial System including vehicle (Drone)	14	14	100%
16	Flood Risk Management Interface	17	10	59%
17	Climate Resilience Seminar	82	90	110%
		468	454	97%

2.5.2 Skills acquired

To reflect the performance of the training, several questions were asked and participants were required to fill a questionnaire form. No name was printed out on the questionnaire forms, thus, confidentiality of the information of the participants was well protected. The questionnaire was handed out at most indoor training sessions. The following is the summary of training / workshops of C3, C7, C8, C9, C10, C11 and C12. From the feedback that we obtained, we can show that the average satisfaction of the training / workshop was good to very good.

Table 3 Feedback from participants

No.	Question	Excellent	Very good	Good	Neutral	Poor
1	How close has the training course met the objectives fully?	19%	43%	34%	3%	1%
2	How useful was the content of the presentations and materials	20%	40%	35%	4%	1%
3	How useful were the exercises in the workshop	19%	33%	41%	8%	0%
4	How significant has the workshop improved your knowledge and skills	13%	35%	45%	7%	1%
5	How relevant or applicable are the knowledge and skills you acquired from the workshop to your work	4%	37%	48%	10%	1%
6	How well instructors share their knowledge with you?	49%	30%	19%	2%	0%

2.5.3 Conclusion

Participation and interest in general has been very good. However, challenges remain in identifying groups of practitioners who can master the whole process of flood proofing infrastructures, from the

vulnerability assessment to improving their resilience. The idea of creating a climate change unit in the MPWT would provide a good foundation for future learning.

3 TRAINING ACTIVITIES IN PHOTOS


Figure 11 Participants in QGIS training session (22nd July and 01st August 2014)


Figure 12 Participants in Culvert Design (July 2014)


Figure 13 Geo-referencing training in progress (30th July 2014)


Figure 14 Embankment Protection Design training session (31st July 2014)


Figure 15 Social Mapping consultation for Community Vulnerability Assessment in Kampong Leaeng district (26th – 27th August 2014)


Figure 16 Road Flood Proofing Tool selection (09th October 2014) and Hydrology and Hydraulic concept (10th October 2014)

Figure 17 Flood modeling with global mapper (08th January 2015) and Hydraulic design with culvert master and HY8 (09th January 2015)

Figure 18 Flood risk management interface (21st January 2015)

Figure 19 Survey Equipment (TOTAL Station + Digital level) (27th – 28th November 2014)


Figure 20 Differential Ground Positioning System – DGPS (16th – 19th December 2014)


Figure 21 Unmanned Aerial System including vehicle – Drone (23rd – 24th February 2015)


Figure 22 Flood Risk Management Interface (30th April 2015)


Figure 23 Climate Resilience Workshop (10th June 2015)

4 KNOWLEDGE MANAGEMENT PLATFORM

The Knowledge management platform developed for CR-PRIP is named “Flood Risk Management Interface”. It is a multi-function application, developed on Microsoft Access (with links to ARC GIS and Global Mapper), that gathers as much possible information and guidelines about road flood proofing and climate resilience as relevant for a public works and transport agency.

4.1 Aim of Flood Risk Management Interface for Roads

The main aim of the application is to provide easy access to existing information about the flood effects on the Cambodian road network, to evaluate the risk of flood damages and impacts on the network and to provide guidelines for improving the resilience of roads.

The Interface enables the user to directly access the relevant data for each individual road section and display, copy and use the required information for purposes such as:

- assessing the flood risk for individual roads in view of various types of flooding, based on current land use and rainfall patterns
- assessing the flooding risk for individual roads for current and future climatic condition (all other aspects being constant)
- prioritizing climate proofing interventions on the basis of flood risk assessment and deciding on the level of intervention
- accessing various road characteristics and condition data, including type, location and condition of existing bridges and culverts
- visualizing the results of post flooding damage assessments
- carrying out checks on roads designs, concerning road drainage or alignment proposals

Figure 24 Flood risk management interface main menu

The application comprises five main menus:

1. Flood Risk Maps
2. Flood Risk Statistics
3. Flood Damage Input
4. Road Information and rehabilitation costing scenarios
5. E-library and Help Files

4.2 Flood Risk Maps and Statistics

One of the main outputs of the PRIP - CR output are flood risk damage maps for various types of floods. All maps are directly linked to the application and can be accessed by the user directly from the interface without the need to open any specific mapping program. The maps are organized on national and provincial level. However, it is also possible to display information on individual road sections as a map, a report, or both.

The main output of the road vulnerability maps is the development of four road risk flooding damage indexes corresponding to different flood types. Another index was build with the combination of the risk of the four flood type for prioritization purposes. These indexes were then associated to all national and provincial roads of the current Cambodian road network, using a model of about 550 individual road sections (about 11,500 km) linked to the MPWT Road Asset Management Project (RAMO) data, which is at the core of the current road maintenance practice in the country.

The five flood risk indexes are:

- Flash Flood Index
- Large Drainage Area Index
- Build-up Area Flooding Index
- Low Land Flooding Index
- Combined flood risk index

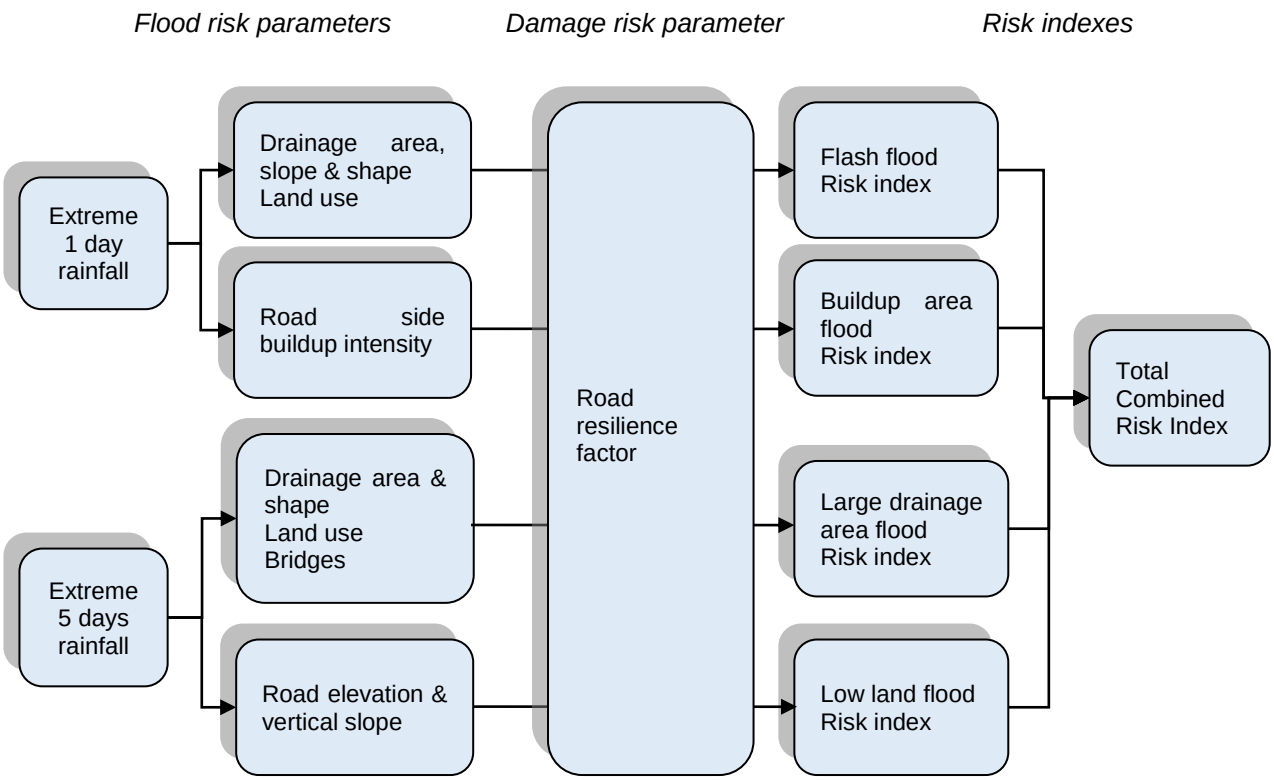


Figure 25 Flood risk calculation process

The calculation process starts by evaluating the risk of occurrence of the four types of flood and then takes the issue to the next level by introducing factors to account for the resilience of the road to these floods. It is important to understand that experiencing flooding or being subject to flood risk does not necessarily inflict a lot of damage to every road. Roads properly designed and maintained in perfect condition will remain at no or at very low risk of flood damage. For example, roads having being recently rehabilitated under major rehabilitation projects will have been upgraded to better withstand flood damages, as prescribed in the Cambodia road standards and in most international road design standards, and are likely to be considerably less damaged through flooding than un-rehabilitated roads. Road resilience is therefore assessed in the model through three indicators, the pavement surface roughness, the pavement type and the condition of the drainage structures. The overall equation is as follows:

Flood damage risk = Risk of flood occurrence x Road condition factors

All these indexes are the basic tools for prioritizing the climate proofing of individual road sections. The results of these flooding risk analyses can be documented in the form of tables, reports and flood risk maps.

A further major output of the project activity has been the investigation of the impact of climate change on the flood risk situation.

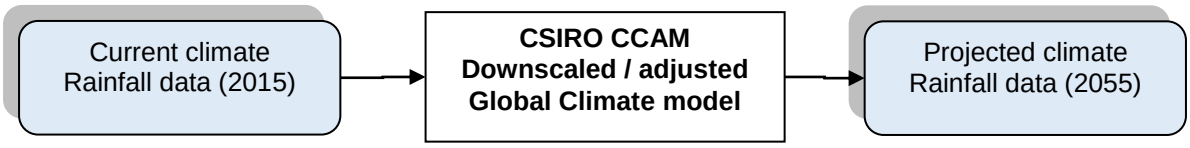


Figure 26 Climate change analysis

Thus, a climate change scenario calculation using the projected 2055 rainfall data has been carried out and the results of these changes where compared to the existing situation. The relevant maps have been produced as part of the CR-PRIP output, at the national scale and for all the provinces.

To map out the five flood indexes for the 25 provinces and to account for the climate change scenarios, more than 250 different maps were produced during the technical assistance. The Flood Risk

Management Interface provides direct access to these maps either through the source application[2] (ARC GIS or Global Mapper) or through graphic formats (jpg or pdf).

The types of maps available are listed in the following table.

Table 4 Types of Maps

Map type
Road references (Link IDs)
Flood damage risks – current conditions
Flood damage risks – future conditions
Flood damage risk changes in time

The process of searching a map is facilitated by the following menu.

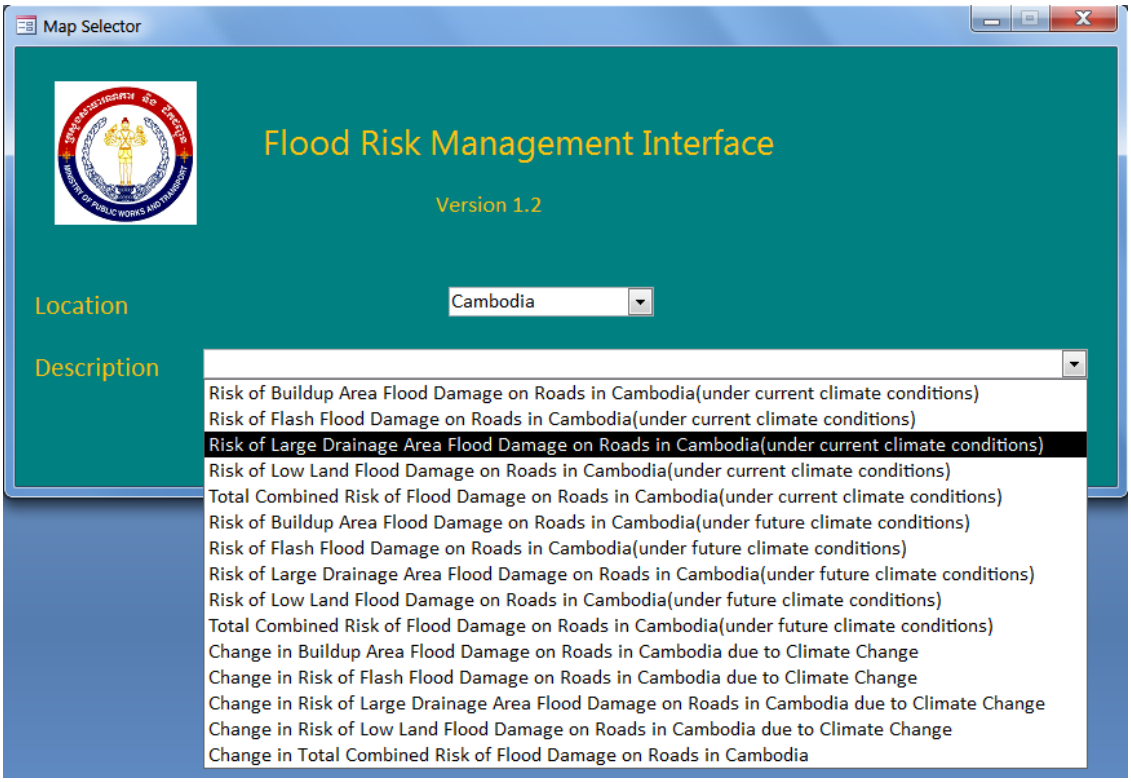


Figure 27 Flood map selection

A typical flood damage risk map shows the road sections associated with four risk levels, ranging from high (red), moderate (orange), low (yellow) to none (green).

[2] Requires separate installation

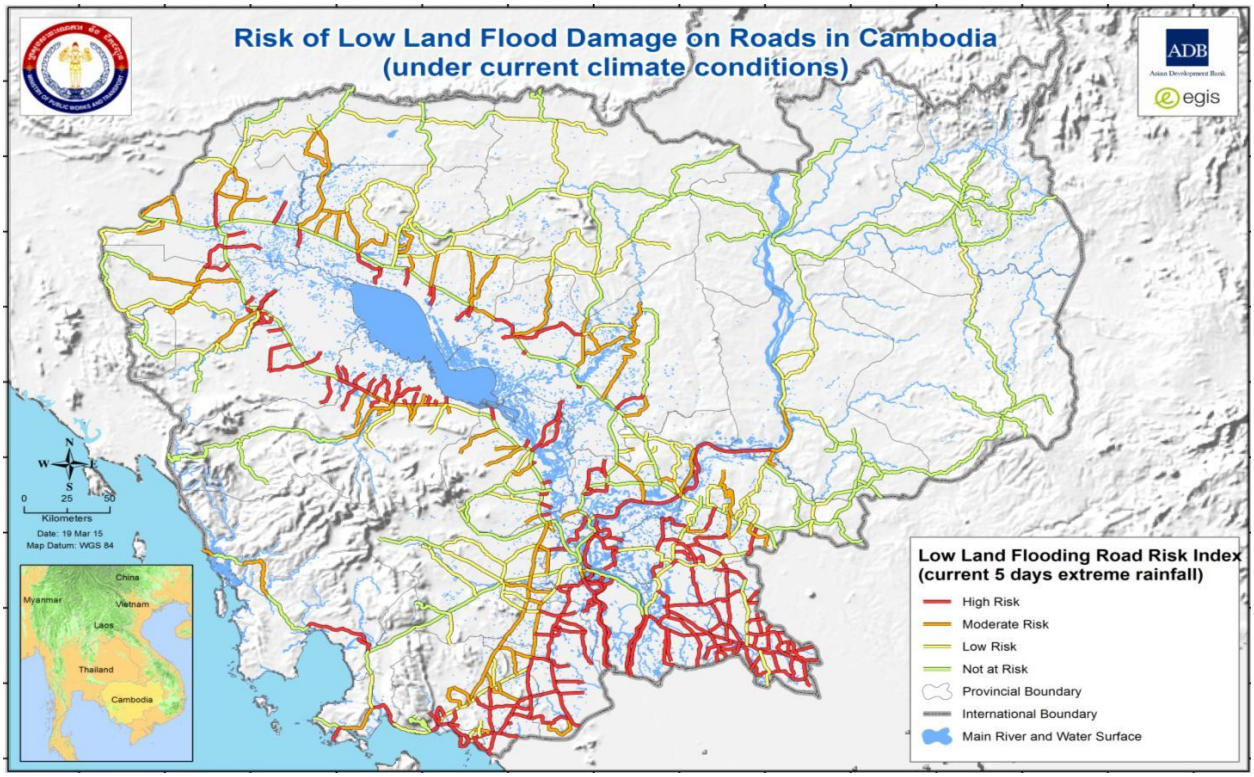


Figure 28 flood damage risk map

This menu enables the extraction of flood risk data and statistics per type of flood or per road for a particular province in view to create a report with that data.

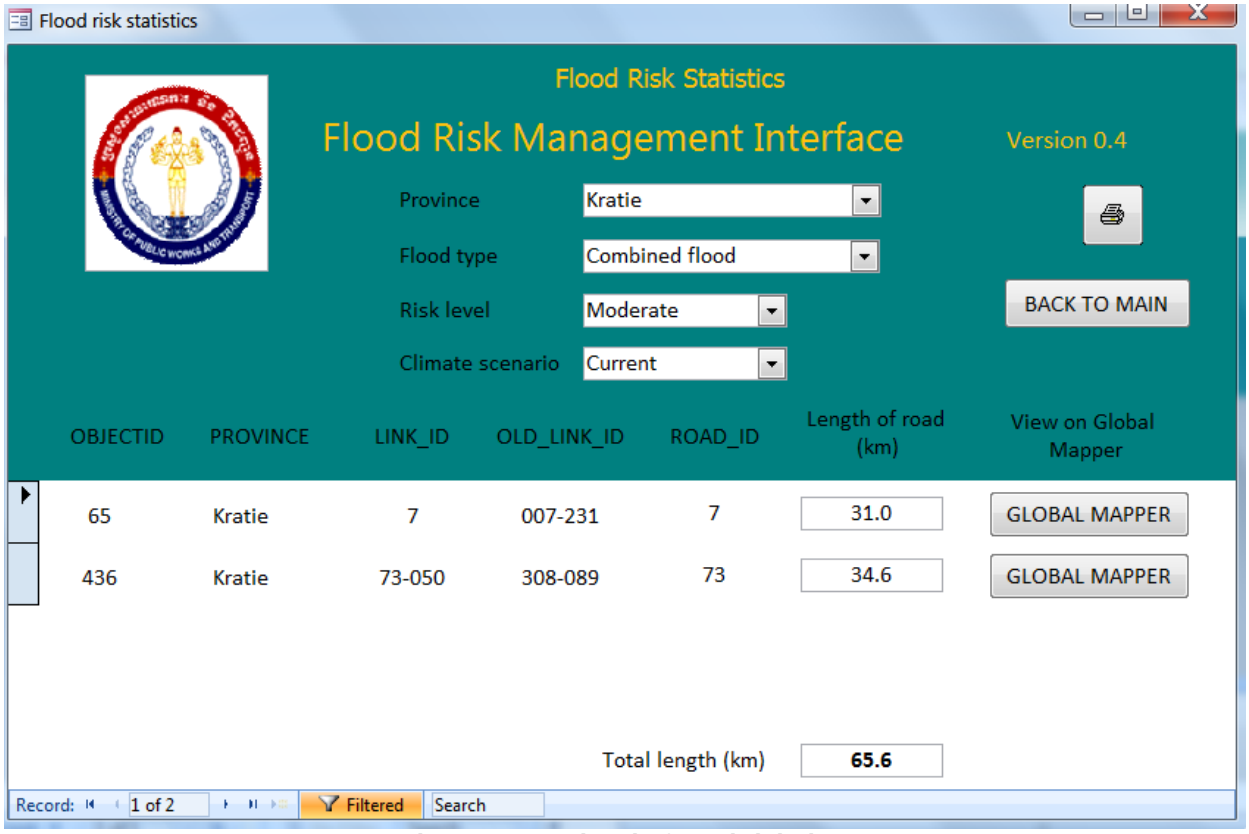


Figure 29 Retrieval of road risk data

4.3 Flood damage database

Flood damage information for recent major floods of 2011 and 2013 has been gathered by the provincial offices at the MPWT and compiled into reports. However, this information was found to be difficult to interpret at a national scale since the basis for collecting that data has never been normalized. Therefore,

in order to complement the current flood damage data collection activities at MPWT, the consultant has developed a new tool to visualize the extent and scope of future flood damage. With that tool a better understanding of the areas at risk will be obtained and possible adjustments to the flood risk models can be investigated.

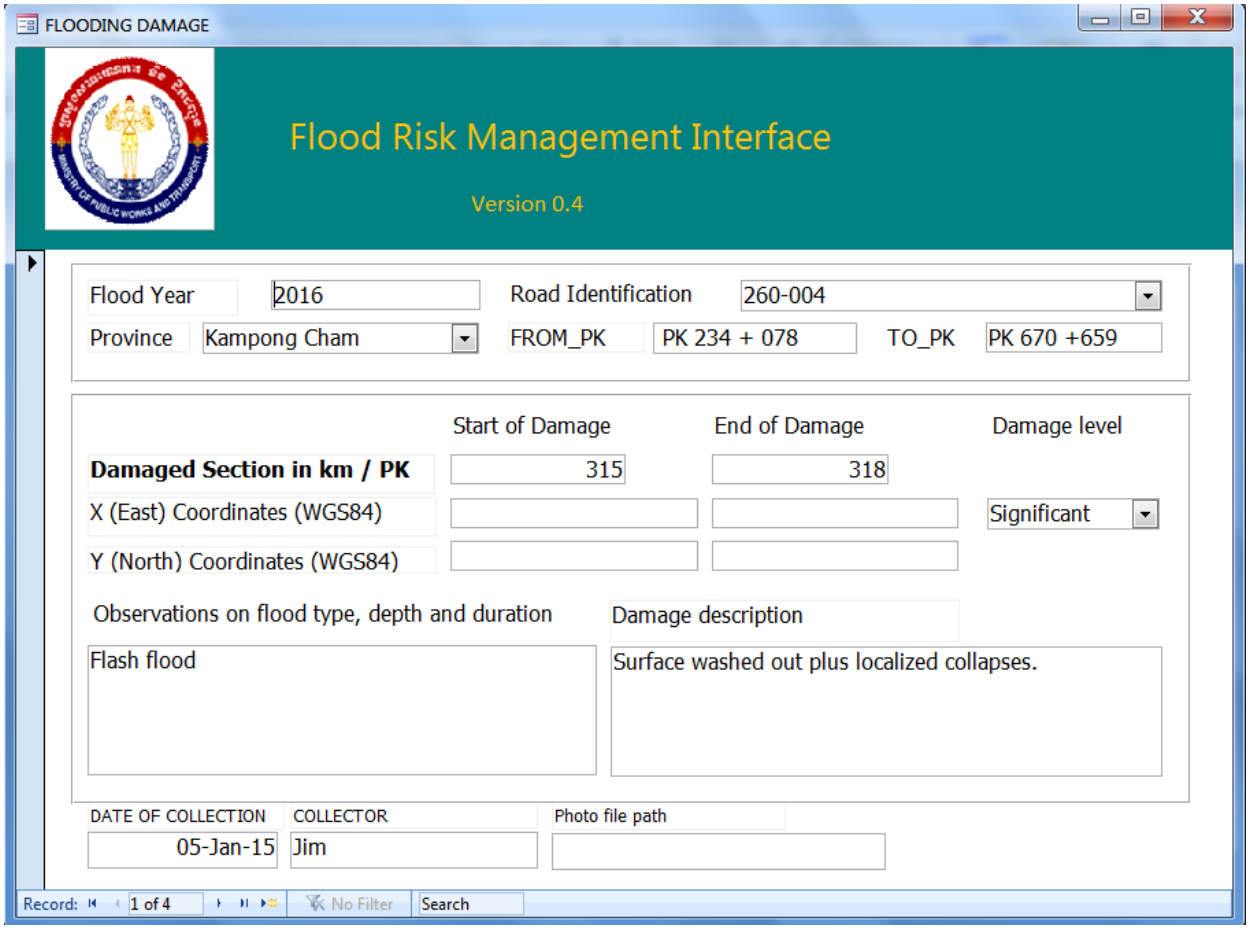


Figure 30 Flood damage data input

A typical mapping of flooded sections is shown below. The key inputs are the GPS coordinates of the damaged areas which can be inserted into the Arc GIS maps.

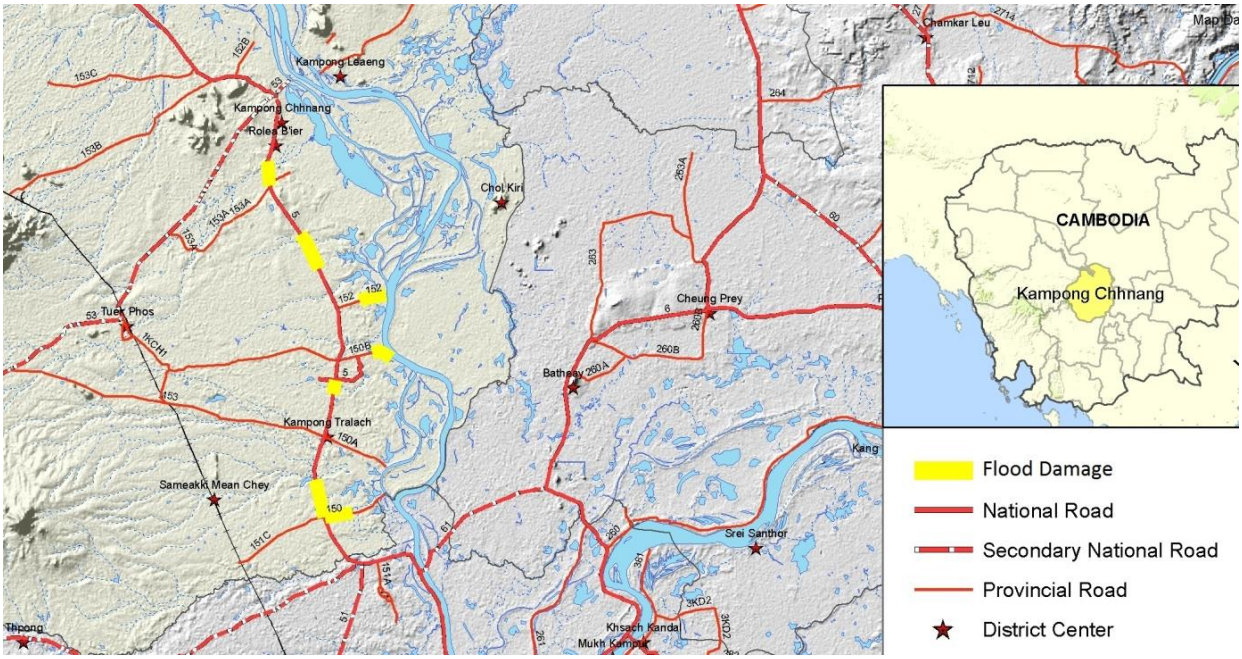


Figure 31 Road sections damaged by floods

4.4 Road Information and Rehabilitation costing scenarios

Road information

Basic road infrastructure data such as bridges, culverts and road alignments can be retrieved easily from the MPWT RAMO database. The RAMO data base has a solid operational base. There are about 550 individual road links on national and provincial level registered in the database, along with more than 13,000 bridges, culverts and other drainage related structures.

Various files from the RAMO system are used to update the road information in the Flood Risk Management Interface. These files can be updated by qualified RAMO system operators.

All relevant road characteristics road condition data and drainage structures are stored in the database. Other information such as catchment areas or land use along the road can also be assessed quickly via the road information menu. The following road data is accessible directly from that menu:

- Geometric road parameters: Road Alignment, Length, vertical alignment of terrain, slopes
- Flood Risk Indices, with a link to 550 catchment area maps (Drainage AREA VIEWER)
- Inventory and condition of culverts and bridges for each road section (Drainage structures)
- Road condition (International roughness index: IRI RAMO)
- Land use
- Pavement type (Pavement surface)
- Recent major rehabilitation details (Recent rehabilitation data)

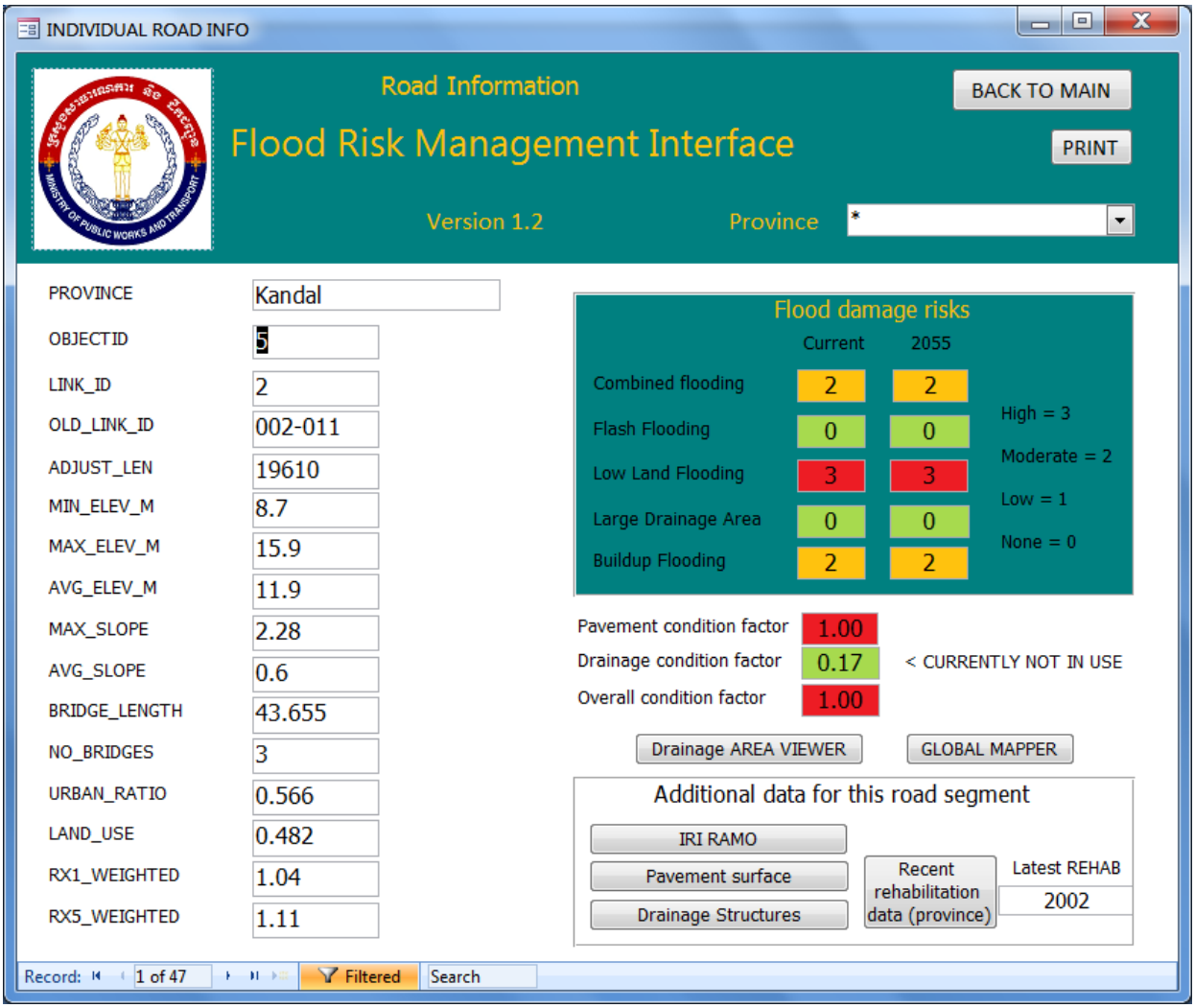


Figure 32 Road Information menu

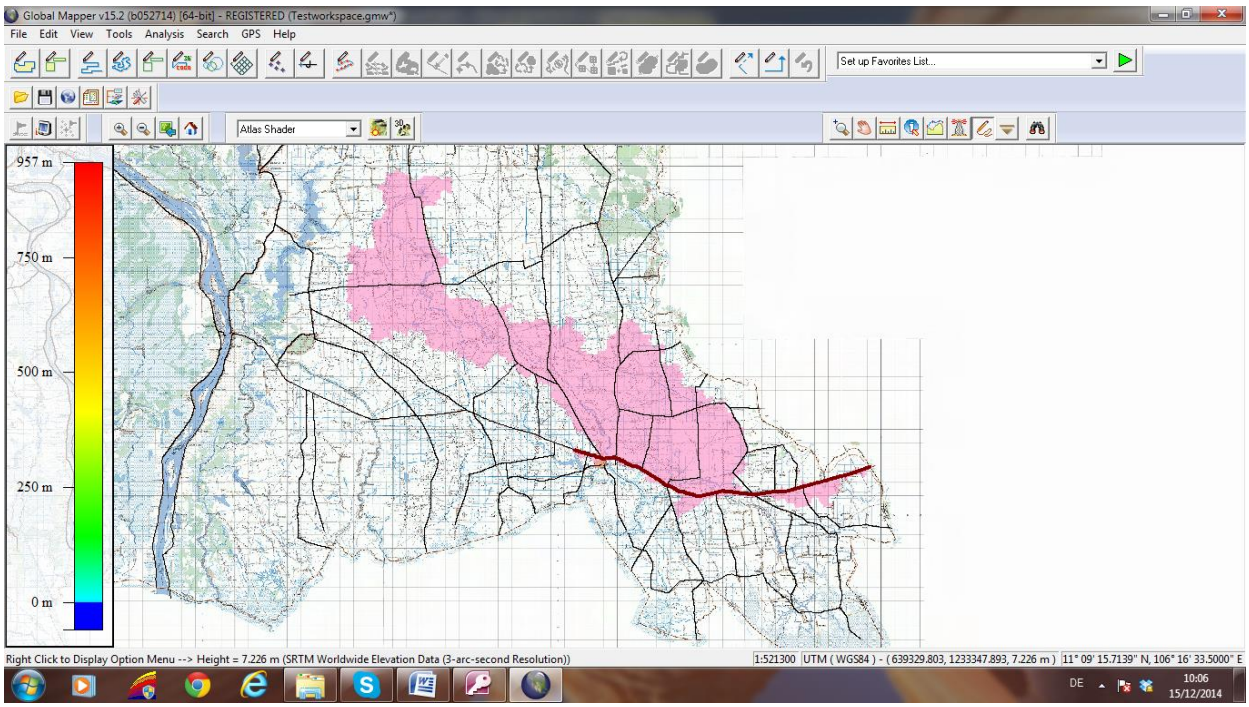


Figure 33 Road catchment (drainage) areas

Rehabilitation costing scenarios

A quick budgeting tool is available for a preliminary estimation of flood proofing initiatives. Several road segments can be selected for rehabilitation and flood proofing measures such as road raising, replacement of culverts, adding embankment protection and using A/C pavements can be assigned to each of those segments. A number of combinations called scenarios can then be assessed and compared. The most interesting scenarios would then be further investigated through traditional design and analysis methods to confirm the scope of the interventions.

4.5 E-library and help files

This module provides access to documents, help files and reports (including all CR-PRIP reports) relevant to flood proofing roads and climate resilience for the Cambodian context. New documents can be added and a category parameter facilitates their filtering. The current document list is given in Appendix 3 and the documents have been included in the following categories:

- MRC reports and documents
- CR-PRIP reports
- Research papers and studies
- FRMI help files
- Flood proofing roads
- Cambodia road standards and specifications
- Reference flood maps

The topics of the documents are expected to expand and eventually cover more document types such as:

- ASEAN Road/Bridge design specification
- Test data from MPWT laboratory
- All development projects carries out by MPWT by donors, by year, by location etc.
- All reports and photo of all infrastructure studies
- Engineering related books in Khmer, English and French
- Engineering related information on softwares
- Engineering related information on hardware in survey, drilling etc.
- Soil type within kingdom of Cambodia
- Traffic information
- Road network
- Traffic management information
- Engineering related training

Figure 34 e-library

4.6 Recommendations

In the short to medium term, it is recommended to integrate this knowledge management platform into a Ministry wide network, and to assign responsible persons for its maintenance and for its dissemination to the development partners.

Longer term recommendations to ensure the sustainability of the new skills and the new knowledge are provided in the next Chapter.

5 COUNTINUOUS TRAINING PROGRAM AND FUTURE CLIMATE CHANGE UNIT

The ultimate goal of the acquisition of new knowledge is to enable government staff be able to perform its duty by integrating the new concepts into its workplace. To ensure the sustainability of the knowledge improvement initiatives, a framework made of two important elements must ideally be build: the establishment of a Climate Resilience (CR) unit within MPWT and continuous capacity building and technical support through short and long term training and workshop for the CR unit and the practitioners.

5.1 The establishment of CR unit within MPWT

The main objective of establishing a climate resilience unit in the MPWT is to ensure that in the future all roads within Kingdom of Cambodia are operational all year round and its design / maintenance takes into account CR factors.

Since CR deals with a number of existing functions of MPWT, the CR unit shall preferably be established as an independent body under the auspice of a high ranking official within MPWT. This unit would report directly to top management of MPWT and linked with the projects and the social and environmental division of the MPWT planning department.

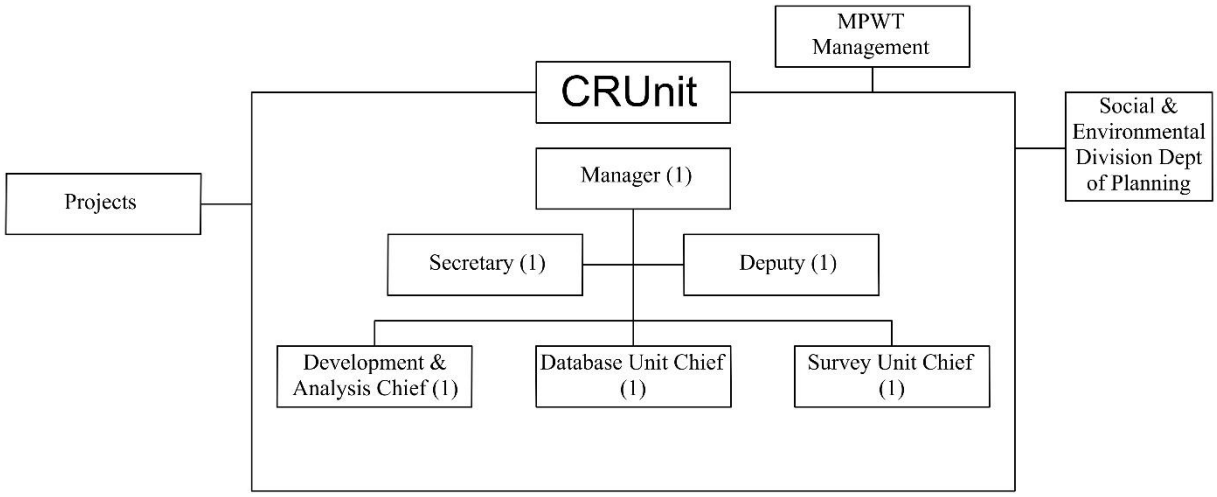


Figure 35 CR unit organization chart

The staff could be hired from within MPWT or sub-contracted from public (with outstanding skill/experience where it could not be found within the ministry). The staff who works in this technical unit shall meet the following qualification:

Table 5 Qualifications of CR unit staff

No.	Position	Quantity, person	Qualifications
1	Manager	1	• MPWT staff veteran with more than 20 year experience in management position. • At least 40 years old with more than 10 years working experience in mapping and survey data processing • Good command of English • Excellent interpersonal relationship • High motivation to work in office and in the field • Able to use survey equipment (TOTAL station, level, Drone) and mapping software (ArcGIS, QGIS, Adobe Illustrator) • At least master degree in Civil Engineering or related field
2	Deputy Manager	1	• MPWT staff veteran with more than 15 year experience in management position. • At least 35 years old with more than 7 years working experience in mapping and survey data processing • Good command of English • Excellent interpersonal relationship • High motivation to work in office and in the field • Able to use survey equipment (TOTAL station, level, Drone) and mapping software (ArcGIS, QGIS, Adobe Illustrator) • At least master degree in Civil Engineering or related field
3	Survey Unit Chief	1	• MPWT staff veteran with more than 10 year experience. • At least 30 years old with more than 5 years working experience in mapping and survey data processing • Able to communicate in English • High motivation to work in office • Able to use survey equipment (TOTAL station, level, Drone) and mapping software (ArcGIS, QGIS, Adobe Illustrator) • At least bachelor degree in Civil Engineering or related field
4	Database Unit Chief	1	
5	Development & analysis Chief	1	
6	Secretary	1	• Good command of English • Excellent computer skill (Typing speed is at least 50 WPM – 100% accuracy) • At least 2 year experience working as secretary or project assistant

Each key staff in this unit has the following role and responsibility:

Table 6 Functions and responsibilities of CR unit staff

No.	Position	Quantity, person	Functions and responsibilities
1	Manager	1	• Oversee general function of the unit • Keep MPWT top management abreast • Coordinate with MPWT, other agencies/ministries and donors • Oversee the project planning, implementation and reporting • Approves data to be released to the public
2	Deputy Manager	1	• Acting manager upon his absent • Manage day to day activity • Keep top management and public abreast (run website or facebook account of CR unit) • Ensures that Flood risk management interface (FRMI) content is up to date • Organizes training activities for climate resilience practitioners in MPWT • Conduct regular quality control within unit
3	Survey Unit Chief	1	• Conduct data collection before, during and after road/bridge rehabilitation/maintenance/repair • Provide technical ad-hoc to non-output staff.
4	Database Unit Chief	1	• Record information (Data entry) • Keep the information clean and update on time • Produce maps as required by the recipient • Ensure that all road/bridge statistic information is properly recorded and kept • Collect information from other MPWT sectors / department to be recorded
5	Development and analysis Chief	1	• Analyze information • Collect research on CR from international or regional sources in order to identify best suitable solution to Cambodia context • Proposes gradual improvements to FRMI models
6	Secretary	1	• Create, operate and maintain filling system. • Other tasks are to be assigned by Manager

Operational Support

To ensure the sustainability of the CR unit, continuous support with man, material and money is essential. A summary table of operating costs for the CR unit is shown below.

Table 7 Operating costs of CR unit (excl. salaries and master courses)

Type	Annual costs USD
Hardware maintenance	2,000
Software upgrades	1,000
Workshop activities	5,000
Surveying / field activities	3,000
Total	11,000

5.2 Future Capacity Building Program

This section provides directions for setting up a long term capacity building program for climate resilience practitioners in the MPWT, looking first at the course contents and then at the implementation methodology.

Contents

A number of regular training courses are recommended for the unit and for the MPWT practitioners, covering both English language and software skills.

To catch up with the up-to-date software development plus to be able to handle the tasks effectively and efficiently, the courses shall be at least one per year.

Table 8 Regular courses or training

Topic	Type of training
English	Formal using local training institutes. Part time evening courses are the most convenient formats.
Arc GIS	Formal using local training institutes.
Q-GIS	As above
AutoCAD	As above
Global mapper	By invitation of international trainer assisted by local trainer. 3 days minimum. Several levels training to be organized with practical examples.
HEC-RAS	As above
Culvert Master	As above

In addition some staff should be offered longer and more in depth courses, such as master courses. Two of these courses of particular interest have been identified and are listed below:

Master course: UK

- University: De Montfort University Leicester
- Degree: Climate Change and Sustainable Development MSc/PG Dip/PG Cert
  (See more at: http://www.dmu.ac.uk/study/courses/postgraduate-courses/climate-change-and-sustainable-development-msc.aspx#sthash.OININW7f.dpuf)
- Fee (Full time, int. student): 12,000 pound
- Intake: Last intake September 2014

Master course: Thailand

- University: Asian Institute of Technology (AIT)
- Master degree in Climate Change and Sustainable Development
  (Sample fees are available at http://www.serd.ait.ac.th/wpserd/cost-and-expenses/)

Finally, e-learning is a growing learning tool that enables more people to access easily to new knowledge. United Nation (UN) provides very good distance learning course on Climate Change (Source: http://unccelearn.org/). The candidate has to register and able to pursue its academic work while staying in touch with its current work place. These courses are free.

Methodology

The proposed capacity building program is divided into a “train the trainer” phase and an “in-house training” phase.

Phase 1: Train the trainer

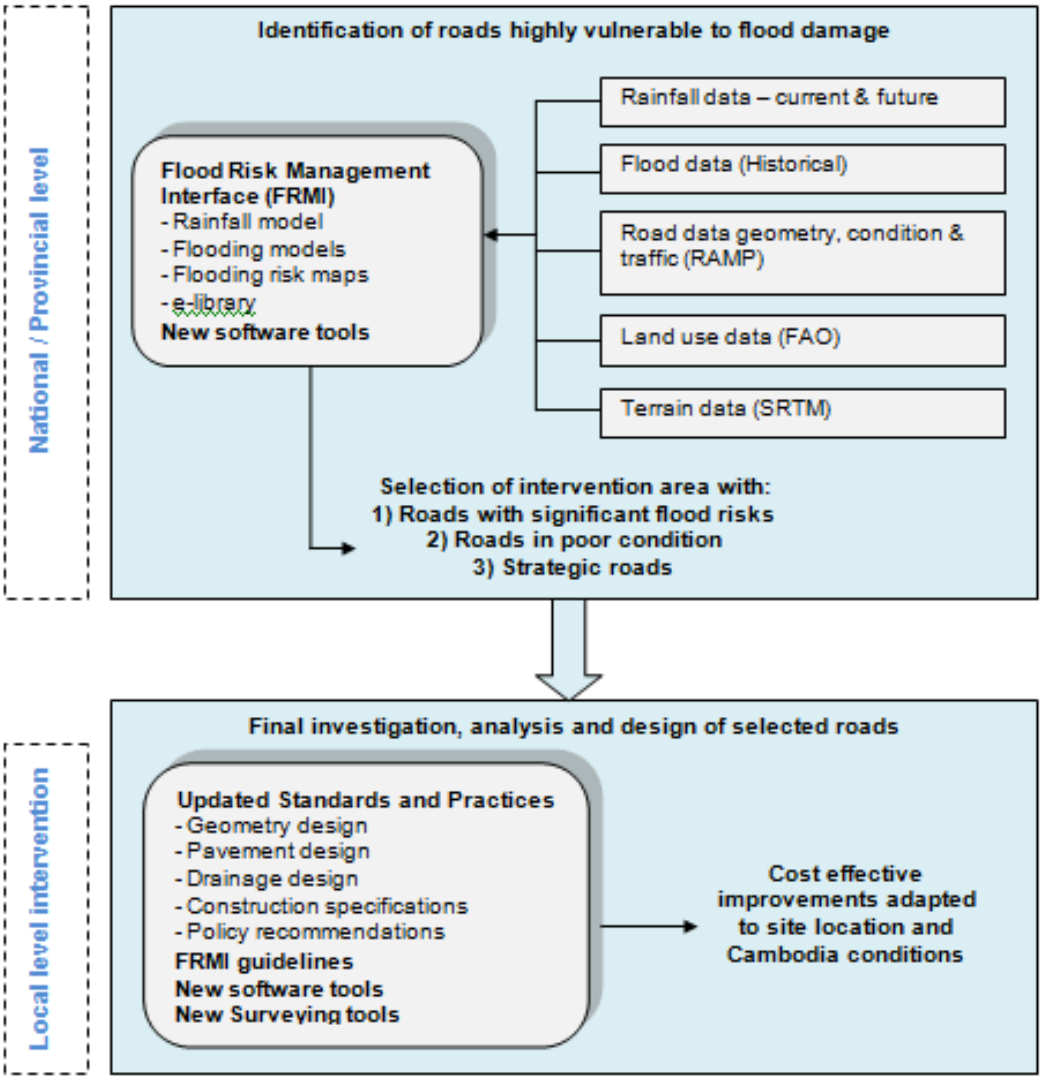
- Instructors: consultants or supplier or software instructor
- Target: CR unit expert staff & future trainers
- Number of participants: less than 5
- Recurrence: every 5 years

Phase 2: In-house training

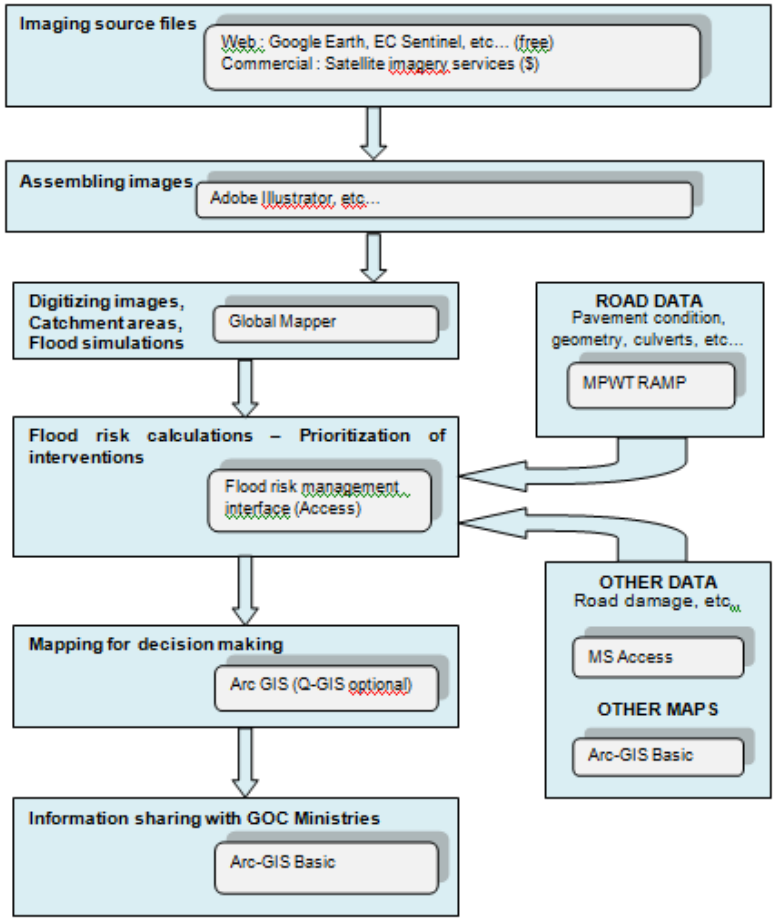
- Instructors: first batch trainers
- Targets: government staff who come from MPWT or other ministries
- Number of participants: less than 10
- Recurrence: repeat and monitor performance
- Participants are selected from various ministries. To be eligible to participate in the training, they shall meet the following criteria:
  - Government staff
  - Women are encourage to participate
  - Knowledge and experience in using Window, MS-Office is preferable
  - English language proficiency
  - Engineering background is a plus

Appendix 1: Software introduced in flood proofing processes

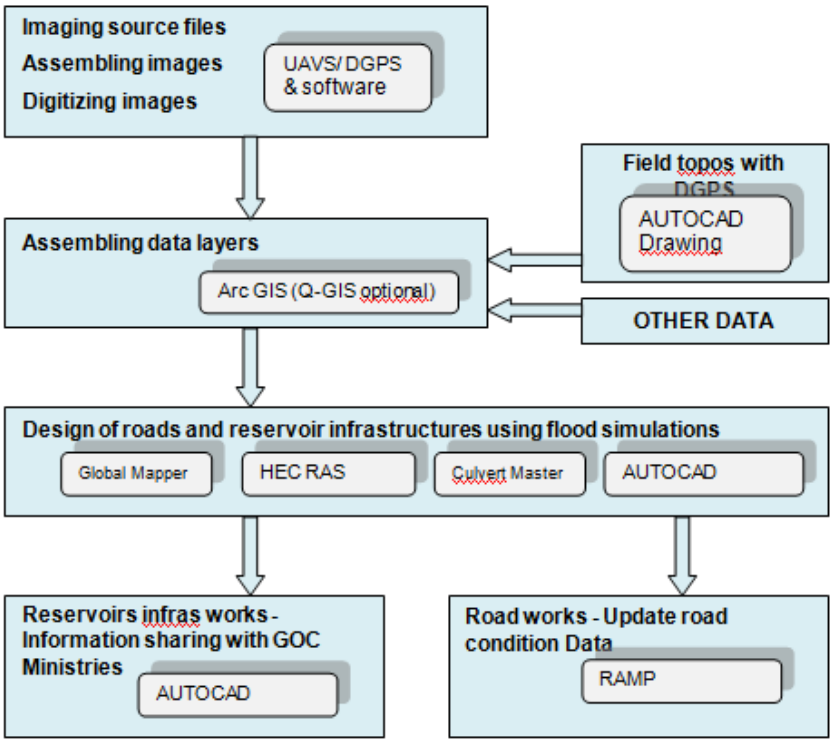
Overall flood proofing process for roads



Software tools for planning phase



Software tools for design phase



Appendix 2: Dates of training events

Dates of training events

No.	Course Name	Date
1	Introduction to QGIS Training Course	22 Jul. 2014
2	Culvert Design	24 Jul. 2014
3	Vulnerability Mapping to Increase Climate Resilience	29 Jul. 2014
4	Geo-Referencing	30 Jul. 2014
5	Embankment protection design	31 Jul. 2014
6	Advanced QGIS	1 Aug. 2014
7	Social Mapping Consultation for Community Vulnerability Assessment in Kampong Leaeng district	27 Aug. 2014
8	Road Flood Proofing Tool selection	9 Oct. 2014
9	Hydrology and Hydraulic concept	10 Oct. 2014
10	Flood modeling with global mapper	8 Jan. 2015
11	Hydraulic design with culvert master and HY8	9 Jan. 2015
12	Flood risk management interface	21 Jan. 2015
13	Survey Equipment (TOTAL Station + Digital level)	27-28 Nov. 2014
14	Differential Ground Positioning System (DGPS)	16-19 Dec. 2014
15	Unmanned Aerial System including vehicle (Drone)	23-24 Feb. 2015
16	Flood risk management interface	30 Apr. 2015
17	Climate Resilience Workshop	10 Jun. 2015

Appendix 3: e-library document list

Flood Risk Management Interface

Document title: Bridge design standard

Short description:

Category: Cambodia road standards and specifications

Document date: 2003

Document title: Construction specifications section 1

Short description:

Category: Cambodia road standards and specifications

Document date: 2003

Document title: Construction specifications section 10

Short description:

Category: Cambodia road standards and specifications

Document date: 2003

Document title: Construction specifications section 11

Short description:

Category: Cambodia road standards and specifications

Document date: 2003

Document title: Construction specifications section 2

Short description:

Category: Cambodia road standards and specifications

Document date: 2003

Document title: Construction specifications section 3

Short description:

Category: Cambodia road standards and specifications

Document date: 2003

Document title: Construction specifications section 4

Short description:

Category: Cambodia road standards and specifications

Document date: 2003

Document title: Construction specifications section 5

Short description:

Category: Cambodia road standards and specifications

Document date: 2003

Document title: Construction specifications section 6

Short description:

Category: Cambodia road standards and specifications

Document date: 2003

Document title: Construction specifications section 7

Short description:

Category: Cambodia road standards and specifications

Document date: 2003

Document title: Construction specifications section 8

Short description:

Category: Cambodia road standards and specifications

Document date: 2003

Document title: Construction specifications section 9

Short description:

Category: Cambodia road standards and specifications

Document date: 2003

Document title: Part 1: Geometry

Short description:

Category: Cambodia road standards and specifications

Document date: 2003

Document title: Part 2: Pavement

Short description:

Category: Cambodia road standards and specifications

Document date: 2003

Document title: Part 3: Drainage

Short description:

Category: Cambodia road standards and specifications

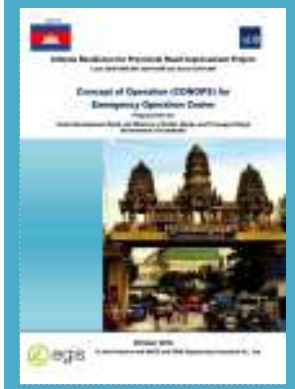
Document date: 2003

Document title: Climate modeling report

Short description: Provides results of the latest model for predicting rainfall and temperature changes for a time horizon of 40 years in Cambodia. Sourced from CSIRO model developed in 2012. Includes comparisons of performance of several other models adapted for the region.

Category: CR-PRIP reports

Document date: Feb-15



Document title: Concept of operation for emergency operation center

Short description: Guidelines for the operation of an emergency operation center in Kampong Leaeng district, Kampong Chhnang province

Category: CR-PRIP reports

Document date: Oct 2014

Document title:	Ecosystem restoration report
Short description:	
Category:	CR-PRIP reports
Document date:	Jun-15

Document title:	Emergency warning system summary concept
Short description:	
Category:	CR-PRIP reports
Document date:	

Document title:	Knowledge management report
Short description:	This report informs about all the training conducted during the CR-PRIP and on the knowledge management tools developed for flood proofing roads. Includes recommendations for maintaining the skills acquired.
Category:	CR-PRIP reports
Document date:	Apr-15

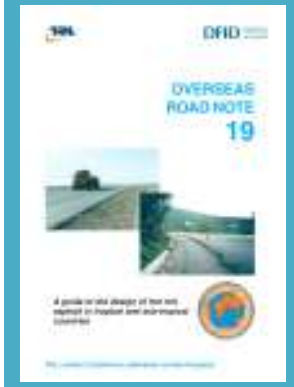
Document title:	Reinforcing community flood resilience
Short description:	Assessment of community capacity to adapt to flood events in Kampong Leaeng district, Kampong Chhnang province
Category:	CR-PRIP reports
Document date:	Sept 2014

Document title:	Road design standards changes
Short description:	Recommendations for improving Cambodia road design standards, design practices and road policies to better account for flood impacts.
Category:	CR-PRIP reports
Document date:	Apr-15

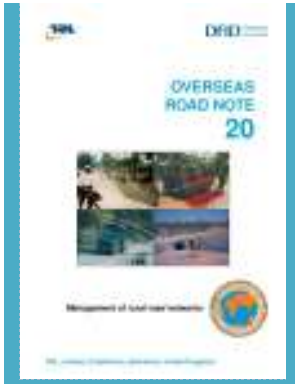
Document title:	Standard operating procedures for emergency response to floods
Short description:	Emergency operating procedures for floods in Kampong Leaeng district, Kampong Chhnang province
Category:	CR-PRIP reports
Document date:	Oct 2014

Document title:	Vulnerability mapping report
Short description:	This report assembles several models for assessing the risk of road flood damages for current climate conditions and future climate conditions. Flood risk maps were prepared for all Cambodia provinces showing the risk using a color code. Also includes socio-economic vulnerability maps for local areas under the project and a description of processes and software tolls for the flood proofing planning phase.
Category:	CR-PRIP reports
Document date:	Mar-15

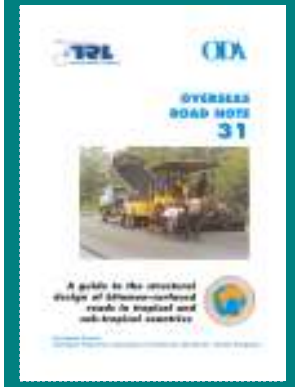
Document title:	TRL Overseas road note 1: Road maintenance management for district engineers
Short description:	Comprehensive road management practices
Category:	Flood proofing roads
Document date:	2003



Document title:	TRL Overseas road note 19: Guide to the design of hot mix asphalt in tropical and sub-tropical countries
Short description:	Comprehensive design methods and specifications.
Category:	Flood proofing roads
Document date:	2002



Document title:	TRL Overseas road note 20: Management of rural road networks
Short description:	Comprehensive road management practices
Category:	Flood proofing roads
Document date:	2003



Document title:	TRL Overseas road note 31: A guide to structural design of bitumen-surfaced roads in tropical and sub-tropical countries
Short description:	Comprehensive design methods and specifications.
Category:	Flood proofing roads
Document date:	1993

Document title:	Flood Risk Management Interface manual
Short description:	Description of functions and features of the Flood risk management interface developed in Access.
Category:	FRMI help files
Document date:	Apr-15

Document title:	How to insert new road segments into FRMI
Short description:	FRMI help file
Category:	FRMI help files
Document date:	Apr-15

Document title:	How to update FRMI drainage structures condition data
Short description:	FRMI help file
Category:	FRMI help files
Document date:	Apr-15

Document title:	How to update FRMI land use and urban ratio data
Short description:	FRMI help file
Category:	FRMI help files
Document date:	Apr-15

Document title:	How to update FRMI pavement condition data
Short description:	FRMI help file
Category:	FRMI help files
Document date:	Apr-15

Document title:	Impacts of climate change and development on Mekong flow regimes First assessment - 2009. Technical paper No 29
Short description:	First major attempt at predicting Mekong flow regimes for future climate conditions. Several scenarios were analyzed included rudimentary observed data trend (10 Y horizon), and downscaled / adjusted regional climate models for longer climate change and development modeling (50Y horizon). Development changes found to be at least as important as climate changes.
Category:	MRC reports and documents
Document date:	2010

Document title:	Roads and floods. Technical paper No 35
Short description:	Best practice guidelines for the integrated planning of economicaly sound and environmentally friendly roads in the Mekong floodplains of Cambodia and Vietnam. Includes several recommendations for taking into account floods into road planning and for conducting studies to provide a better understanding of the road flood damage factors.
Category:	MRC reports and documents
Document date:	Oct-11

Document title:	Dartmouth Flood Observatory: Cambodia flood 2000
Short description:	
Category:	Reference flood maps
Document date:	2006

Document title:	WFP: Cambodia floods 2011 and 2013
Short description:	
Category:	Reference flood maps
Document date:	2013

Document title:	Assessment of the susceptibility of roads to flooding based on geographical information.
Short description:	By Versini, Gaume and Andrieu. Tested in Gard region, France.
Category:	Research papers and studies
Document date:	2010