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Final Report

CONSULTANCY TO ASSESS THE CURRENT HAZARD MAPPING CAPACITY AND EFFECTIVENESS OF SCENARIO BASED TOOLS FOR LONG TERM PLANNING MECHANISMS

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LIST OF ABBREVIATIONS

Acronyms	
CC	Climate Change
CCA	Climate Change Adaptation
COOPI	Cooperazione Internationale
DBM	Database Management
DoDMA	Department of Disaster Management Affairs
DPD	Director of Planning Department
DRR	Disaster Risk Reduction
DRM	Disaster Risk Management
EAM	Evangelical Association of Malawi
EO	Earth Observation
EU	European Union
EWS	Early Warning System/s
FEWS NET	Famine and Early Warning Systems Network
GI	Geo-Information
GIS	Geographic Information Systems
GoM	Government of Malawi
GSD	Geological Survey Department
HQs	Headquarters
IPCC	International Panel for Climate Change
MVAC	Malawi Vulnerability Assessment Committee
NGO	Non-governmental organisation
NSDI	National Spatial Data Infrastructure
SDI	Spatial Data Infrastructure
UNDP	United Nations Development Programme
Z_GIS	Centre for Geoinformatics, Paris-Lodron University Salzburg (PLUS), Austria

Table 1: Abbreviations

For a **glossary** of terms please refer to the terminology developed by UNISDR
➔ http://www.unisdr.org/we/inform/terminology

1 INTRODUCTION

1.1 General background

The Government of Malawi (GoM), through the Ministry of Development Planning and Cooperation, with support from the Japanese Government and the United Nations Development Programme (UNDP), is implementing a two-year project *'Building Capacity for Integrated and Comprehensive Approaches to Climate Change Adaptation in Malawi (AAP Malawi)'*. The **objective** of the project is to enhance Malawi's existing climate initiatives by strengthening capacity for long term investment, and management of climate-resilient sustainable development. This will be achieved through the realisation of the following five **outputs**:

1. Dynamic, long-term planning mechanisms to manage the inherent uncertainties of climate change introduced;
2. Leadership capacities and institutional frameworks to manage climate change risks and opportunities in an integrated manner at the national and local levels strengthened;
3. Climate-resilient policies and measures implemented in priority sectors;
4. Financing options to meet national adaptation costs at national and local levels expanded;
5. Knowledge on adjusting national development processes to fully incorporate climate change risks and opportunities generated and shared across all levels.

The Italian non-governmental organisation (NGO) Cooperazione Internationale (COOPI, *www.coopi.org*) and its partner the University of Salzburg's Centre for Geoinformatics (Z_GIS, *www.zgis.at/research*) provide support to various governmental and non-governmental institutions to carry on Geo-Information (GI) activities related to Disaster Risk Reduction (DRR). In a previous assessment (April 2010), the two agencies recognised the need to conduct a systematic and comprehensive study to assess the existing capabilities and related geo-spatial datasets, including a gap analysis, in order to develop a long-term adaptation plan and materialise within it a set of usable tools and methodologies. This will enable the development of climate-related hazard and vulnerability maps and scenarios to manage the inherent uncertainties of climate change.

The consultancy, funded by the UNDP, addresses the **gaps** identified in the aforementioned assessment. Consequently, the consultancy includes the identification of the data gap to be filled, and the methodologies to be applied enabling appropriate mapping integrated in a full GIS (Geographic Information Systems) product, usable at multiple levels and by all the relevant stakeholders dealing with disaster risk reduction (DRR) and climate change.

In order to promote the development of a capacity building programme, the current consultancy also incorporates the following aspects:

- Identification of specific human resources and capacities within government agencies.
- Recommendations on the provision of training.
- Creation of a detailed list of hardware, software and data to be purchased/collected.
- Identification of appropriate innovative technologies.
- Budget plan recommendations in line with the country's priorities and potentialities.

The consultancy includes the use of appropriate GIS and Earth Observation (EO) technologies adapted to the objectives of the aforementioned two-year project *'Building Capacity for Integrated and Comprehensive Approaches to Climate Change Adaptation in Malawi (AAP Malawi)'*.

1.2 Climate change scenarios relevant to Malawi

The Copenhagen Diagnosis of 2009, designed as an update on the IPCC's fourth assessment report (IPCC 2007[*]), identified the potential for a temperature rise by 2100 of as much as 7ºC if there were no action to cut emissions. Newly emerging science is in many ways pointing to so-called 'tipping points' - sudden and perhaps irreversible changes accompanied by feedback mechanisms. Both observations reinforce the need for planning adaptation measures in good time.

Concerning food security, temperature rises alone may be more severe in impact than previously thought. A paper this year in Nature Climate Change[†], has tapped previously unused data from more than 20,000 maize trials in Africa. It has concluded that roughly 65% of present maize-growing areas in Africa would experience yield losses following a 1ºC warming, even under optimal rain-fed management.

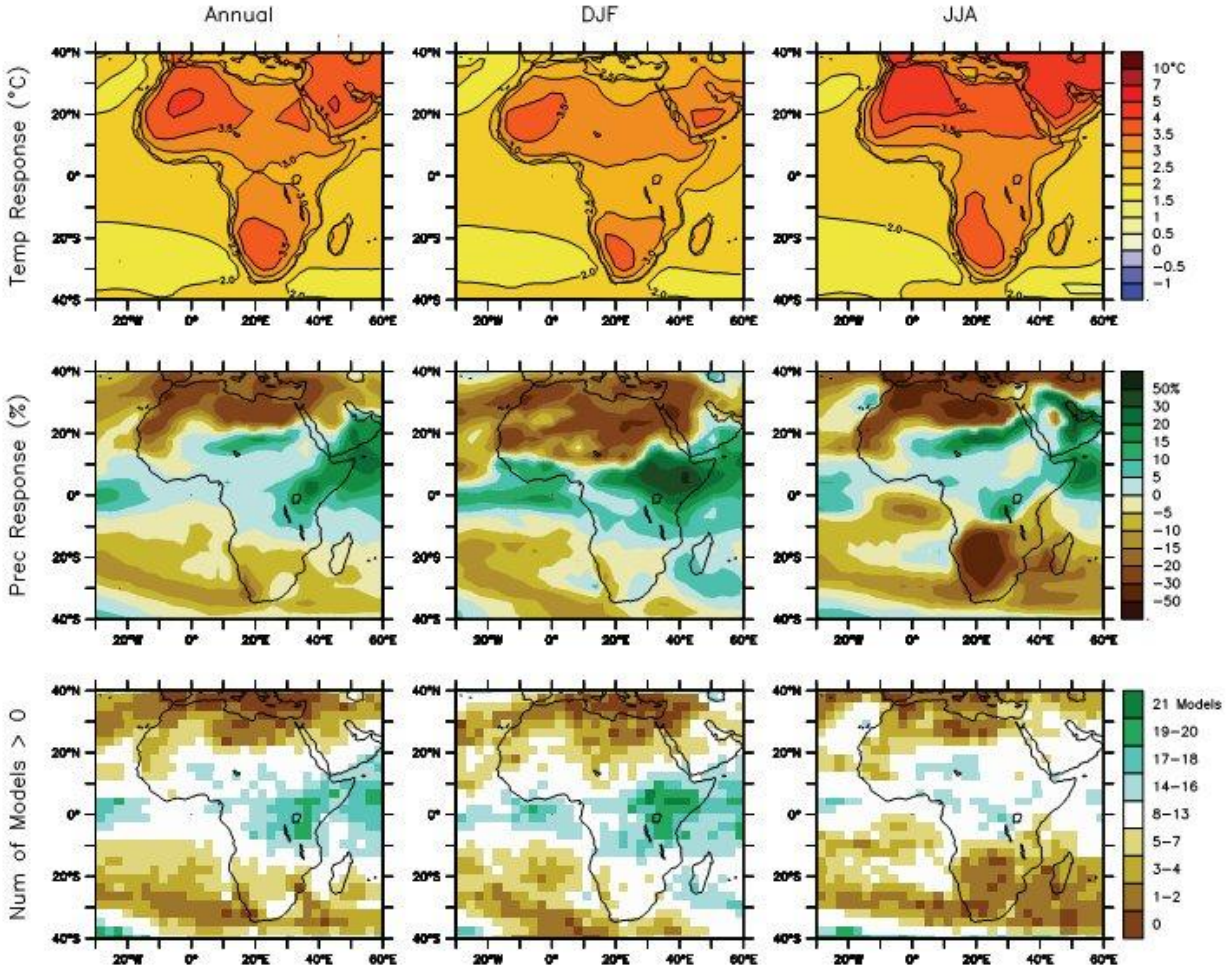


Figure 1: Temperature and precipitation changes over Africa from the MMD-A1B simulations. Top row: Annual mean, DJF (December, January, February) and JJA (June, July, August) temperature change between 1980 to 1999 and 2080 to 2099, averaged over 21 models. Middle row: same as top, but for fractional change in precipitation. Bottom row: number of models out of 21 that project increases in precipitation (IPCC 2007; see also Hewitson 2006[‡]). Note: summer rainfall predictions are specifically heterogeneous for Southern Africa including Malawi.

In Southern Africa, the frequency of extremely dry winters and springs increases to roughly 20%, while the frequency of extremely wet summers doubles in this collective model.

[*] IPCC: Climate Change 2007:The Physical Science Basis, Regional Climate Projections (www.ipcc.org)
[†] Lobell B.D. et al. (2011): Nonlinear heat effects on African maize as evidenced by historical yield trials. Nature Climate Change, Volume:1, Pages:42–45
[‡] Hewitson, B.C., and R.G. Crane, 2006: Consensus between GCM climate change projections with empirical downscaling: precipitation downscaling over South Africa. Int. J. Climatol., 26, 1315–1337

To an extent, this can be thought of as a delay to the onset of the rainy season. This spring drying, suppresses evaporation, contributing to the spring maximum in the temperature response.

The key responses to reduce the likely impact of these climate scenarios (Fig. 1) are the adoption of mitigation measures to address one of the causes of the change, which is the increase of greenhouse gas emissions, and planning adaptation measures. Many experts however argue that climate change will aggravate or amplify existing security concerns and give rise to new ones, especially - but not exclusively - in already fragile and vulnerable nations.

Natural disasters
"Sudden natural disasters" displaced some 42 million people in 2010. Many millions of people are also displaced annually as a result of climate-related, slow-onset disasters such as drought[§].

Food Insecurity
Some of the emerging temperature rise scenarios may also challenge the basic ability of some parts of the world to practice agriculture, as a result of crops being unable to tolerate new climatic conditions or, for instance, the drying out of forests.

Conflicts over Resources
Competition over scarce water and land, exacerbated by regional changes in climate, are already a key factor in local-level conflicts in Darfur, the Central African Republic, northern Kenya, and Chad. For example, when livelihoods are threatened by declining natural resources, people either innovate, flee or are brought into conflict. In total, 145 countries share one or more international river basins. Changes in water flows, amplified by climate change, could be a major source of tension between states, especially those that lack the capacity for co-management and cooperation. If we look at the history of peacekeeping operations mandated by the Security Council, we find that 10 operations costing a total of US$35 billion dollars have been deployed to countries where natural resources have played a key role in the conflict.

How can countries, at different points in their development path, work together on a transformative agenda on what is now being termed a resource efficient Green Economy?
(a) Not impeding development, but as a catalyst for investing and re-investing in the kinds of clean technology industries that produce markedly less greenhouse gas emissions and thus reduce the risks of climate change,
(b) Investing in, and managing our ecological infrastructure (forest ecosystems which enhance resilience and store carbon) will be central to a more stable, equitable and peaceful world.
Under the assumption that access to adequate financing is not provided, Africa is the continent most vulnerable to the impacts of projected changes, simply because wide-spread poverty limits adaptation capabilities.

Key impact dimensions

Ecosystems:
State: tropical forests and rangelands are under threat from population pressures and systems of land causing loss of biodiversity, rapid deterioration in land cover and depletion of water availability through destruction of catchments and aquifers.
Change: A sustained increase in mean ambient temperatures beyond 1°C would cause significant changes in forest and range-land cover, species distribution, composition and migration patterns, and biome distribution. Arid to semi-arid sub-regions and the grassland areas of Eastern and Southern Africa, as well as areas currently under threat from land degradation and desertification, are particularly vulnerable.
Adaptive options include control of deforestation, improved rangeland management, expansion of protected areas and sustainable management of forests.

[§] Norwegian Refugee Council and the Internal Displacement Monitoring Centre (IDMC), 2010

Hydrology and Water Resources:
State: Of the 19 countries around the world currently classified as water-stressed, more are in Africa than in any other region—and this number is likely to increase, independent of climate change, but as a result of increases in demand resulting from population growth, degradation of watersheds caused by land-use change and siltation of river basins.
Change: The reduction in precipitation projected by some GCMs for the Sahel and southern Africa - if accompanied by high inter-annual variability - could be detrimental to the hydrological balance of the continent and disrupt various water-dependent socio-economic activities.
Adaptation options include water harvesting, management of water outflow from dams and more efficient water usage.

Agriculture and Food Security:
State: Agriculture is the economic mainstay in most African countries, contributing 20–30% of GDP in sub-Saharan Africa and 55% of the total value of African exports. In most African countries, farming depends entirely on the quality of the rainy season - a situation that makes Africa particularly vulnerable to climate change.
Change: Increased droughts could seriously impact the availability of food, as in the horn of Africa and southern Africa during the 1980s and 1990s. In subtropical Africa, warmer winters would reduce the incidence of damaging frosts, making it possible to grow horticultural produce susceptible to frosts at higher elevations than is currently possible. Productivity of freshwater fisheries may increase, although the biodiversity could be altered.

Human Settlement, Industry and Transportation:
State: The main challenges likely to face African populations will emanate from extreme climate events such as floods (and resulting landslides in some areas), strong winds, and droughts.
Change: Individuals living in marginal areas may be forced to migrate to urban areas (where infrastructure already is approaching its limits as a result of population pressure) should the marginal lands become less productive under new climate conditions. Climate change could worsen current trends in depletion of biomass energy resources. Reduced stream flows would cause a reduction in hydropower production, leading to negative effects on industrial productivity and costly relocation of some industrial plants. Adaptation options include effective management of pollution, sanitation, waste disposal, water supply and public health, as well as the provision of adequate infrastructure in urban areas.

Human Health:
State: Africa is expected to be at risk primarily from increased incidences of vector-borne diseases and reduced nutritional status.
Change: A warmer environment could open up new areas for malaria; altered temperature and rainfall patterns could also increase the incidence of yellow fever, dengue fever, onchocerciasis and trypanosomiasis. Anomalous morbidity and mortality in sub-regions, where vector-borne diseases increase following climatic changes, would have far-reaching economic consequences.
Adaptation options: In view of the poor economic status of most African nations, global efforts will be necessary to tackle the potential health effects.

Tourism and Wildlife:
State: Tourism - one of Africa's fastest-growing industries - is based on wildlife, nature reserves, coastal resorts and an abundant water supply for recreation.
Change: Projected droughts and/or the reduction in precipitation in the Sahel, Eastern and Southern Africa would devastate wildlife and reduce the attractiveness of some nature reserves, thereby reducing income from current tourism investments.

The African continent is particularly vulnerable to the impacts of climate change because of factors such as widespread poverty, recurrent droughts, inequitable land distribution and overdependence on rain-fed agriculture. Although adaptation options, including traditional coping strategies, are theoretically available; in practice, the human, infrastructural and economic response capacity to effect timely response actions may well be beyond the economic means of some countries.

1.3 Objectives and related outputs

The overall **objective of the consultancy** is to contribute to the development and use of long term climate change adaptation tools integrating Geo-Information (GI) for hazard mapping and scenario development.

The outputs of the consultancy are summarised as followed:

Output 1:
An inventory of already **existing risk maps** (hazard and vulnerability maps) and related hazard **mapping capacities** to address climate change (CC) in Malawi (see chapter 3.1). More specifically this includes:

- An assessment of the existing hazard and vulnerability maps and existing climate change related scenarios already available in the country,
- A 'map' of the existing Geo-Information (GIS, remote sensing) for DRR capacities in government and non- government institutions in the country,
- A gap mapping analysis of the necessary (i) hazard maps (ii) resources (iii) expertise/ knowledge and (iv) data required to contribute to the development of long term climate change adaptation tools.

Output 2:
A review of existing **Early Warning Systems** (EWS) in Malawi used by various organisations, measuring accuracy, effectiveness and proposed methodologies for future adaptation and scaling up of suitable EWS (see chapter 3.2). More specifically this includes:

- An assessment including matrix and map of the existing EWS and related methodologies currently used,
- A proposed strategy to scale up and adopt suitable EWS in Malawi based on the gap mapping analysis conducted.

Output 3:
A set of **recommendations** about the various opportunities to produce hazard and vulnerability maps in the context of climate change adaptation (CCA) for long term disaster risk management (DRM) in Malawi (see chapter 3.3). More specifically this includes:

- Practical recommendations on options and possible methodologies to develop hazard and vulnerability maps that will strengthen risk-based management in the context of climate change adaptation. This includes (i) a section about a detailed list and budget forecast of required equipment (software, hardware) and data, including remote sensing and (ii) a section about a training and capacity building plan and operational budget to develop long-term planning scenarios that will strengthen the risk-based management of climate change.
- A capacity building training plan, including budget forecast for:
    - Personnel identification and specific individual thematic training area.
    - Detailed identification of items (hardware, software and data) to be acquired.

The recommendations derived from the two outcomes, present the basis for the future development of accurate and cost effective set of hazard and vulnerability maps in Malawi.

1.4 Structure of the report

Following this **introduction**, providing information on the general background, objectives and expected outputs of the consultancy, **chapter two** gives an overview of the major activities that were conducted within this study as well as the rationale and methodological approaches that were applied to collect and analyse all relevant information and data. Moreover, the chapter also includes a section where the key stakeholders involved in Disaster Risk Reduction (DRR) and Management (DRM) at both national and district level that have been consulted for semi-structured expert interviews are listed. Furthermore, major methodological challenges that the consultants faced during their work are also mentioned.

Chapter three presents the major findings and results of the consultancy and briefly summarises the observed achievements and challenges concerning Geo-Information (GI) for Climate Change Adaptation (CCA) in Malawi.

Building on that, **chapter four** presents the actual recommendations and proposed short- and long-term intervention options how to strengthen/foster existing and new Geo-Information capacities to address DRR and CCA in Malawi.

2 METHODOLOGY

This chapter provides detailed information on the **methodological approaches** and **methodologies** that were applied with regard to the aforementioned strategic objectives of the consultancy (cp. chapter 1). Thus chapter 2.1 first gives a very general overview of the **activities** that were conducted, including detailed information on the rationales as well as on the methodologies that were applied. Building on that, the following chapters then present a more detailed description of the individual activities that were carried out during the consultancy.

2.1 Activities, rationales and methodology

Within this context, table 2 offers information on the activities specifically related to **output 1** (an inventory of already existing risk maps (hazard and vulnerability) and related GIS and hazard mapping capacities related to climate change in Malawi).

No.	Activity	Rationale	Methodology
1.1	Desk study and literature review of existing reports and documents produced by various research, climate change or DRR programs in the country	Overview of previous and current work on DRR and CCA	Literature review using available (online) resources; face-to-face encounter to request reports and documents which are available at key stakeholders' offices
1.2	Survey study (two stages)	Assessment of existing resources and capacities	Stage 1: Key stakeholder analysis and related expertise/resource assessment using semi-structured face to face interviews Stage 2: Assessment of the typology of available geo-spatial and hazard/vulnerability related data available at key stakeholders' offices and collection of existing geo-spatial datasets Each stage will be conducted at both levels: (i) national and (ii) district level
1.3	Mapping of the outcomes of the survey and analysis report	Maximum dissemination and clarity of information	Dissemination of information making use of an existing Web GIS portal developed by COOPI and Z_GIS called *www.gi4drr.org*. The web page is designed for low connectivity and will provide access to all relevant documents and maps

Table 2: Activities related to output 1

In the same manner, table 3 outlines the activities that were conducted with regard to **output 2** (an assessment of the existing Early Warning Systems (EWS) developed in Malawi and used by various actors measuring accuracy, effectiveness and proposed methodologies for future adaptation and scaling up of suitable EWS).

No.	Activity	Rationale	Methodology
2.1	Desk review of existing reports and documents related to early warning (EW) activities in the country	Overview of the location and efficacy of existing EWS as well as of agencies involved in EW activities	Desk literature review using available (online) resources; face to face encounter to request reports/documents which are available at key stakeholders' offices
2.2	Survey study	Physical assessment to evaluate the effectiveness of existing EWS	Systematic interviews with key stakeholders at national and district level. Selection of existing EWS at field level, stratified by typology and hazard related context. This was done within selected sample districts. Within the survey the effectiveness and efficacy of identified EWS was measured based on qualitative data. Furthermore, semi-structured interviews with beneficiaries were

			conducted.
2.3	Classification and mapping of already existing EWS according to their typology and use	Maximum dissemination and clarity of information	Dissemination of information using an existing Web GIS portal developed by COOPI and Z_GIS called *www.gi4drr.org*. The web page is designed for low connectivity

Table 3: Activities related to output 2

Finally, table 4 highlights activities that were conducted to contribute to **output 3** (a set of recommendations about the various opportunities to produce hazard and vulnerability maps in the context of climate change adaptation for long term disaster risk management (DRM) in Malawi).

No.	Activity	Rationale	Methodology
3.1	Preparation of a report showing recommended opportunities to apply methodologies for hazard and vulnerability mapping at national and district level	Provide the necessary recommendations to improve and scale-up appropriate GI technologies for AAP	This is done taking into account a 'consolidated risk framework' establishing a link between DRR and Climate Change (CC) recently developed by the EU funded project 'Methods for the Improvement of Vulnerability Assessment in Europe' (MOVE); *www.move-fp7.eu*
3.2	Discussion with individual national government or committee members about their specific roles and requirements	This represents a preparatory step towards the workshop (see activity 3.3) in order to sensitise and increase the interest and a critical participation of the key stakeholders to the workshop	Face to face semi-structured interviews after the major outcomes of the study have been presented
3.3	One-day workshop about sharing information and strategic capacity building plan with the key relevant national stakeholders (held in Lilongwe, Malawi on October 4, 2011)	The rationale of the workshop is associated to the following needs: (1) to present the outcomes of the results 1 and 2 (2) to have a common understanding of each other roles in relation to data acquisition / data processing and data dissemination in relation to DRR in the frame of CCA. (3) to discuss the outcomes of the consultancy and to agree on a harmonised capacity building process for the 2011-2013 period	COOPI and UNDP invited key stakeholders and COOPI organised the workshop. Z_GIS will facilitate the workshop with two senior researchers. The workshop includes: (i) presentations, (ii) focus group discussion and (iii) working groups
3.4	Preparation of a detailed list and budget forecast of needed equipment (software, hardware) and data, including remote sensing imagery. The consultant team will list and quantify the items to be purchased	Necessary to provide (i) sustainable and (ii) appropriate, usable set of technology tools that the GoM can use for long term planning scenarios that will strengthen the risk-based management of climate change	Market analysis. Trial version of new software packages. Software chosen and tested considering the existing capacities, needs and gaps. Development of an Excel user-friendly table enabling to quantify resources for future purchases. Inventory, test and ranking of the best freeware options per category of supplies (at least 2-3 options per items). Quotation collection using direct contact and request of quotation for one year validity This action also includes the investigation of the remote sensing

			archive data on the online catalogues for the entire country, the preparation of an inventory list of the available historical information available from various satellite agencies and a preliminary negotiation with various remote sensing supplier agencies to obtain favourable prices.
3.5	Reporting		Synthetic report, maps, web site *www.gi4drr.org*

Table 4: Activities related to output 3

2.2 Semi-structured questionnaires

Within the context of the hazard mapping capacity assessment a **semi-structured questionnaire** was developed and used to collect qualitative and quantitative information at both (i) national and (ii) district level. The questionnaire, which comprises 54 questions, covers major aspects such as:

- historic hazard events in the country,
- information on existing Early Warning Systems (EWS) and activities,
- the role of anthropogenic impacts on hazard risk,
- an overview of Disaster Risk Reduction (DRR) and recovery activities,
- existing hazard and vulnerability mapping capacities (knowledge, expertise) and related resources (hardware, software and data),
- information on the National Spatial Data Infrastructure (N-SDI) as well as on institutional arrangements and partnerships.

As indicated before, the developed questionnaire facilitated interviews with key governmental, UN and non-governmental experts and stakeholders involved in DRR and DRM activities at both national and district levels. Tables 5 and 6 give an overview of the stakeholders that were consulted during the in-country assessment.

2.3 Expert-based mapping of hazard prone areas

Building on a previously created base map of the country, an **expert-based mapping exercise** was conducted during the interviews with selected key stakeholders involved in DRR/DRM and CCA (see tables 5 and 6) in order to come up with a final aggregated map showing areas which are particularly prone to natural hazards in the country (see annex 2) according to the interviewed experts.

2.4 Institutional mapping

Institutional mapping of stakeholders that are coordinating and/or implementing DRR/DRM and CCA related activities in the country was another approach for this consultancy. This was achieved through institutional analysis that was conducted as part of the semi-structured interviews with key stakeholders at national and district level. The institutional analysis explored and evaluated official mandates, responsibilities, existing capacities within the relevant agencies/offices and partnerships and cooperation between stakeholders.

2.5 Data and information collection

The procedure for all interviews followed a previously defined and standardised sequence. As a first step, **before the meeting took place,** an appointment for an interview was requested and scheduled by the team of consultants via telephone. As a follow-up activity a letter of support (LoS)

coming from UNDP and the developed semi-structured questionnaires (see chapter 2.2) were sent to the interviewees in order to give them some time to prepare themselves for the upcoming interview and to gather all necessary information that was requested by the consultants. The actual face-to-face interviews were conducted jointly by the two implementing agencies involved in the consultancy within the last week of July and the first two weeks of August 2011. In addition to using hard copies of the semi-structured questionnaires for the taking of notes, all face-to-face interviews were recorded on digital voice recorders. Prior to the interview, the stakeholders were informed that all information would remain completely confidential and would not be used for other purposes than the consultancy.

During the interview and in line with the developed semi-structured questionnaires the interviewees were asked to provide detailed information on:

- their agency's contact details and mandate
- historic hazard events and areas which are particularly prone to natural hazards (cp. chapter 2.3)
- existing Early Warning Systems (EWS) and related activities
- the role of anthropogenic impacts or factors on increased risk from natural hazards (e.g. degradation, population growth, etc.)
- past and present DRR and recovery activities
- available Geo-Information (GIS, remote sensing, data management and handling) capacities (human capacities as well as related technical and financial resources) which are available within the agency or department.

In addition, the interviewed experts were asked to provide (i) detailed inventory lists of available hazard and risk maps, hardware, software and geo-data (GIS and remote sensing data), (ii) an organigram of their institution as well as (iii) a copy of the geo-datasets which are currently available at their departments or agencies.

Several days **after the interviews**, a reminder was sent to the interviewed experts (first by mail and then also by telephone) to provide the requested inventory lists as well as the copy of the existing geo-datasets.

2.6 Key stakeholders consulted during the consultancy

As indicated above the following tables list the **key governmental, international (UN, EU, etc.) and non-governmental DRR and DRM stakeholders** that were consulted on national (table 5) as well as on district level (table 6) during a four-week in-country assessment in July and August 2011. Thereby, the stakeholders were selected by the consultants according to their official mandate and relevance as an actor in the field of DRR/DRM and CCA in Malawi. The focus was set to the DRR focal points (FPs) listed on the 'Malawi DRM Stakeholder Contact Details' list that was provided by the Department of Disaster Management Affairs (DoDMA).

ID	Stakeholder s (national level)	Location	Type	Date/s
01	Geological Survey Department	Lilongwe	Government	29.07.2011
02	Geological Survey Department , HQs	Zomba	Government	08.08.2011
03	Department of Disaster Management Affairs (DoDMA)	Lilongwe	Government	29.07.2011
04	Climate Change and Meteorology Department	Lilongwe	Government	01.08.2011
05	Land Survey Department	Lilongwe	Government	02./03.08.2011
06	Ministry of Irrigation and Water Development	Lilongwe	Government	04.08.2011
07	Ministry of Natural Resources, Energy and the Environment	Lilongwe	Government	05.08.2011
08	Ministry of Agriculture and Food Security – 1. Technical Secretariat	Lilongwe	Government	26.08.2011

	2. Department of Land Resource and Conservation			28.11.2011
09	Ministry of Local Government and Rural Development	Lilongwe	Government	24.08.2011
10	Department of Forestry	Lilongwe	Government	05./09.08.2011
11	National Statistical Office (NSO)	Zomba	Government	08.08.2011
12	Training Research Institutions / Universities / 1. Bunda College of Agriculture (Lilongwe) 2. Mzuzu University, (Mzuzu) 3. The Polytechnic, (Blantyre) 4. Chancellor College (Zomba)	Lilongwe	Government	 14.09.2011 18.11.2011 21.11.2011 22.11.2011 23.11.2011
13	UNICEF	Lilongwe	UN	15.09.2011
14	World Bank	Lilongwe	UN	02.08.2011
15	United Nations Development Programme (UNDP)	Lilongwe	UN	03.08.2011
17	World Food Programme (WFP)	Lilongwe	UN	26.08.2011
16	EU Delegation	Lilongwe	EU	15.09.2011
18	FEWS NET Malawi	Lilongwe	Civil society	09.08.2011
19	MVAC	Lilongwe	Civil society and government	24.10.2011

Table 5: Stakeholders (national level)

As shown in table 5 a total of twelve key governmental institutions, five international and one civil society (i.e. NGOs) organisations were visited during the consultancy at national level. In addition several key stakeholders involved in DRR or CCA activities were consulted within five selected districts (i.e. Salima, Chikwawa, Nsanje, Kasungu and Karonga). These districts have been selected for several reasons. Firstly, they are particularly prone to natural hazards (especially floods) and secondly, some three of them are operating community-based flood Early Warning Systems which have been installed and are maintained by different civil society organisations under the EC DIPECHO programme (*http://ec.europa.eu/echo/aid/dipecho_en.htm*). The stakeholders that were consulted in these five districts are listed in table 6.

ID	Stakeholder s (district level)	District	Type	Date/s
01	Ministry of Irrigation and Water Development	Salima	Government	12.08.2011
02	Department of Disaster Management Affairs (DoDMA)	Salima	Government	15.08.2011
03	Forestry Department	Salima	Government	16.08.2011
04	Cooperazione Internationale (COOPI)	Salima	Civil society	15.08.2011
05	Department of Disaster Management Affairs (DoDMA)	Chikwawa	Government	02.09.2011
06	Director of Planning Department (DPD)	Chikwawa	Government	02.09.2011
07	Evangelical Association of Malawi (EAM)	Chikwawa	Civil society	01.09.2011
08	Department of Disaster Management Affairs (DoDMA)	Nsanje	Government	06.09.2011
09	Goal Malawi	Nsanje	Civil society	06.09.2011
10	Director of Planning Department (DPD)	Kasungu	Government	08.09.2011
11	Director of Planning Department (DPD)	Karonga	Government	12.09.2011

Table 6: Stakeholders (district level)

Please note that the study did not include COOPI and its partner ZGIS for obvious reasons of the author's vested interests. Complementary information of the consultancy agencies is available in a separate annex at the end of this report.

2.7 Data analysis

Structure of the analysis

Qualitative data:

The interviewers were experts in both, GIS/Remote Sensing and DRR. The interviews provided valuable information about the stakeholder knowledge of climate change and DRR. It was possible to verify some of the documents, scientific publications and reports cited by the stakeholders interviewed. Moreover during the interviews the stakeholders were asked to rank their own capacity of managing geo-data and for the provision and sharing of data.

2.8 Quality Assurance

Quality assurance is a crucial point in the evaluation and mapping of Geo-Information (GI) capacities in any context. The quality of the research methodologies and data analysis is ensured by the academic team of the University of Salzburg's Centre for Geoinformatics (Z_GIS). The review was done according to accepted international standards. The questionnaire for the semi-structured interviews was developed, tested and validated by an expert sociologist making use of a pre-test before the actual interviews were conducted.

2.9 Methodological challenges

During the four-week in-country assessment the consultants faced some minor **methodological challenges**, which are briefly summarised in this chapter. One particular challenge arose from the fact that in general only one, or in rare cases, two, key experts were available for the interviews within the relevant offices; this made it difficult in some cases to fully cover all aspects listed in the semi-structured questionnaire. Consequently, not all stakeholders were able to provide sufficient answers to all questions, as some of them were beyond their personal expertise. A second challenge arose due to the format of the semi-structured questionnaire itself. Taking almost two hours to discuss all relevant aspects, some of the experts interviewed lost motivation to provide detailed information on all questions and in some cases providing insufficient data. Information management and sharing procedures did, in most cases, fail to get (immediate) access to existing geo-spatial datasets or relevant reports and documents which are available within the consulted offices. These challenges were partly overcome by making use of alternative sources of information, which comprises a review of literature and online sources and by sending several reminders (via e-mail and telephone) to the interviewed experts in the days after the interviews. However, some of the interviewed experts failed to make some of the requested documents, inventory lists and datasets available, even after several reminders had been sent.

3 RESULTS

This chapter presents the **results** of the consultancy. The first sub-chapter discusses the findings of the assessment of existing risk maps and related mapping capacities, while the second sub-chapter provides an overview of existing Early Warning Systems (EWS) in the country and critically reflects their strengths, weaknesses as well as potential strategies to improve their effectiveness and to scale them up. Finally, the last sub-chapter summarises the observed achievements and challenges concerning the use of Geo-Information (GI) for Climate Change Adaptation (CCA) in the country.

3.1 Assessment of existing risk maps and related hazard mapping capacities

As indicated in the introduction (cp. chapter 1) a major objective of the consultancy was to provide an overview of existing risk maps (i.e. hazard and vulnerability maps) as well as of related hazard mapping capacities within key departments or agencies in the country. Building on that, this chapter presents the outcomes of the assessment of (i) **existing hazard and vulnerability maps**, (ii) related **mapping capacities** (i.e. Geo-Information for DRR and CCA capacities) as well as of (iii) **existing gaps** in terms of available human, financial and technical resources, expertise and knowledge that is required to contribute to the development of long term climate change adaptation tools. Therefore, as outlined in chapter 2.5 the consulted stakeholders were asked to provide detailed inventory lists of:

- existing **geo-hazard and risk maps** (flood, drought, earthquake maps, etc.) that have been produced by their department or agency,
- the GIS, GPS and remote sensing **datasets** which are available at their department or agency,
- **Hardware** (i.e. number of laptops, desktop computers, GPS receivers, etc.) and dedicated GIS or remote sensing **software** available at their office.

Table 7 provides an aggregated view of the number of stakeholders that have been visited at national level and shows the percentage of stakeholders that have (i) committed themselves to provide inventory lists and (ii) actually provided the requested inventory lists.

Stakeholders (national level)	# of stakeholders visited	# of stakeholders who committed to provide inventory lists	# of stakeholders who actually provided inventory lists
Government institutions	12	9 (= 75.0 %)	7 (= 58.3 %)
International organisations (UN, EU, etc.)	5	1 (= 20.0 %)	1 (= 20.0 %)
Civil society organisations	1	1 (= 100.0 %)	1 (= 100.0 %)
Total (Σ)	**18**	**11 (= 61.1 %)**	**9 (= 50.0 %)**

Table 7: Status quo of the requested inventory lists

3.1.1 Existing hazard and vulnerability maps

Based on the semi-structured interviews that were conducted among the key stakeholders listed in table 5 and the requested inventory lists, this chapter provides an overview of **existing maps** which are already available within the consulted departments and agencies. As the focus was set to **hazard** and **vulnerability maps** these are displayed in bold characters. In addition, table 8 demonstrates whether the existing maps are primarily static (i.e. analogue paper maps, digital maps, etc.), dynamic (web-based, i.e. using Google Earth or Web-GIS, etc.) or both.

ID	Stakeholder s (national level)	Existing maps	Static	Dynamic	Both
01	Geological Survey Department	• **Geo-hazard maps** (landslide maps) • **Seismological maps**	X		
02	Geological Survey Department , HQs	• **Geo-hazard maps** (earthquake maps) • **Seismological maps**	X		
03	Department of Disaster Management Affairs (DoDMA)	-	-	-	-
04	Climate Change and Meteorology Department	• Weather maps • Temperature maps • Rainfall maps			X
05	Land Survey Department	• Maps showing agricultural practices • Topographical maps • Maps showing water levels at lakes • Cadastral maps	X		
06	Ministry of Irrigation and Water Development	-	-	-	-
07	Ministry of Natural Resources, Energy and the Environment	-	-	-	-
08	Ministry of Agriculture and Food Security	• Maps showing agricultural practices • Topographical maps • Maps showing river streams at lakes	-	-	X
09	Ministry of Local Government and Rural Development	-	-	-	-
10	Department of Forestry	• Forestry maps • **Wildfire maps**	X		
11	National Statistical Office (NSO)	• Census maps	X		
12	Universities / Colleges	-	-	-	-
14	UNICEF	-	X	-	-
14	World Bank	- Hazard maps (consultancies)	X	-	-
15	United Nations Development Programme (UNDP)	-	-	-	-
16	World Food Programme (WFP)	• Maps showing river streams at lakes • General thematic maps	X	-	-
17	EU Delegation	-	-	-	-
18	FEWS NET Malawi	• Present and future severity of food security maps • **Weather hazard maps** (flood, dryness, drought)			X

Table 8: Existing (hazard and vulnerability) maps

It becomes obvious that (i) only very few of the consulted stakeholders have experience in the production and publication of hazard-related map products and that (ii) none of the stakeholders have ever created or published vulnerability-related map products (iii) there is little awareness of each other products availability. According to the interviewed experts this can be primarily traced back to lacking hazard mapping capacities (see next chapter). However, it is also obvious that significant specific expertise in geo-hazard mapping is available within some key departments. For example the Geological Survey Department (GSD) who have strong expertise in the mapping of

earthquake and landslide prone areas (particularly in the areas of Karonga, Michesi and Zomba mountains and Thunduwike) or the USAID-funded civil society organisation FEWS NET (Famine and Early Warning Systems Network) who have significant experience in the monitoring and mapping of food security and related weather hazards which might have a strong impact on food security in the region.

3.1.2 Existing Geo-Information (GI) capacities

This chapter gives an overview of the **existing Geo-Information (GI) for DRR and CCA capacities** that are available within key departments and agencies at both **national** (cp. chapter 3.1.2.1) and **district level** (cp. chapter 3.1.2.2). Thereby, the presented capacities are presented using an aggregated view, meaning that a clear distinction is made between existing capacities within **government institutions**, capacities of **international organisations** (i.e. UN, EU, etc.) and capacities of **civil society organisations** (i.e. NGOs). The following major aspects among others have been considered in order to evaluate the existing Geo-Information capacities within the consulted key ministries, departments or agencies:

- number and qualification of dedicated personnel/staff and their level of training,
- availability and usage of dedicated GIS software packages plus number of licenses,
- availability and usage of dedicated remote sensing software plus number of licenses,
- availability of dedicated hardware,
- availability of geo-spatial datasets (GIS, GPS, remote sensing data, etc.),
- data management (data storage, availability of backup-systems, meta-data, etc.),
- data sharing procedures and institutional knowledge on spatial data infrastructure (SDI),

3.1.2.1 National level

As indicated above, this chapter provides an overview of the existing Geo-Information (GI) for DRR and CCA capacities at national level. During the four-week in-country assessment it became evident that the general picture varies between and within institutions, but specific Geo-Information (GI) capacities exist within some of the offices that were visited.

Staff/personnel working with Geo-Information (GI) technology

The assessment of existing GI for DRR and CCA capacities has shown that to date a dedicated GIS (Geographic Information Systems) unit is operated only at the National Statistical Office (NSO) in Zomba, whereas no dedicated GIS or remote sensing units exist within other departments or agencies. However, according to the experts interviewed, efforts are being made to establish dedicated GIS units within both the Land Survey Department and the Geological Survey Department (GSD) at present. Nonetheless, most of the governmental institutions consulted (see table 5) have, depending on existing individual human capacities (existing knowledge, expertise, level of training, etc.), some personnel/staff working with GI-technology. In most cases these staff are working independently from each other. The key players operating at a national level concerning the number of personnel working with GIS and/or remote sensing software and data, are the Geological Survey Department (GSD), the National Statistical Office (NSO), the Land Survey Department, Bunda College and the Ministry of Agriculture and Food Security. However, the level of training and the academic background in Geo-Information technology of these persons varies between and within institutions and existing capacities within the departments or agencies and are often based on single individual capacities. The analysis has also shown that hardly any human GI capacities exist within international organisations; this can be primarily traced back to the fact that GI-related tasks are often outsourced by contracting external consultants or consultant firms. As only one NGO was consulted at a national level (see table 5) it would difficult to make a profound statement on human GI capacities within civil society organisations; however, it seems

that the level of training, and thus staff-related GI capacities are generally higher in NGOs than in other institutions (i.e. government and international organisations). Finally, it was observed that with the exception of the National Statistical Office (NSO) and the Department of Forestry, no dedicated personnel were employed with direct responsibility for GI for DRR and CCA.

GIS and remote sensing software

As with the personnel, the availability and usage of dedicated GIS and remote sensing software packages also varies between institutions. Table 9 gives an overview of the software packages that are available and utilised within the consulted stakeholder's offices. Where available, information is provided on the number of official licenses that are available within the departments or agencies.

ID	Stakeholder s (national level)	GIS software	Remote sensing software
01	Geological Survey Department	• ArcGIS • ArcView • MapInfo	-
02	Geological Survey Department , HQs	• ArcGIS • ArcView • Surfer	• ENVI
03	Department of Disaster Management Affairs (DoDMA)	-	-
04	Climate Change and Meteorology Department	no data	no data
05	Land Survey Department	• ArcGIS (5 licenses) • ArcView	• ERDAS Imagine (2 licenses)
06	Ministry of Irrigation and Water Development	-	-
07	Ministry of Natural Resources, Energy and the Environment	-	-
08	Ministry of Agriculture and Food Security	• ArcGIS (1 license)	-
09	Ministry of Local Government and Rural Development	-	-
10	Department of Forestry	• ArcGIS • ArcView • ILWIS	• ERDAS Imagine • ENVI • ILWIS
11	National Statistical Office (NSO)	• ArcGIS (10 licenses)	-
12	Universities / Colleges	• ArcGIS (education edition) • ArcView • GRASS (open source)	• ERDAS Imagine (education edition)
13	UNICEF	-	-
14	Worldbank	-	-
15	United Nations Development Programme (UNDP)	-	-
16	World Food Programme (WFP)	-	-
17	EU Delegation	-	-
18	FEWS NET Malawi	• ArcGIS (2 licenses)	-

Table 9: Existing GIS/remote sensing software packages within the consulted offices

The evaluation clearly shows that the Bunda College, the Land Survey Department, NSO, the Forestry Department and the Geological Survey are the best equipped stakeholders in terms of GIS and/or remote sensing software. International organisations did not reveal to have any GIS or remote sensing software at all. Based on table 9, figure 1 shows the prevalence of specific commercial and open-source software packages within the consulted offices - the size of the letters representing the predominance of the software packages. It becomes obvious that the commercial GIS software ArcGIS is the most commonly used among the consulted stakeholders. It is interesting to note that Bunda College is the only stakeholder making use of freely available

open-source software, especially when such software has a high potential to fill the user's needs and requirements whilst at the same time being free of charge.

Figure 2: Prevalence of specific GIS/remote sensing software packages within the consulted offices

Although most of the consulted offices are equipped with either one or the other software (primarily commercial GIS software packages), it became very obvious that most of the institutions are lacking official software licenses and thus specific advanced analysis, mapping tools and extensions as well as respective official service support and regular updates. Moreover, most of the experts interviewed mentioned that their institutions are working with out-of-date versions of these software packages, primarily due to a lack of funds to upgrade their software regularly.

Dedicated hardware

Based on the analysis of the requested inventory lists and the semi-structured interviews, not only the available software but also the existing hardware and IT equipment were recorded. This was in order to be able to make profound recommendations on potential short and long-term investment options (see chapter 4). The analysis has revealed that most of the stakeholder's offices are equipped with either insufficient, broken or out of date hardware (this includes personal computers (PCs), laptops, monitors, data storage (servers, external memories, etc.), GPS receivers and GPS cameras, scanners, printers or plotters as well as routers that could enable high-speed internet connection). Again it became obvious that governmental institutions are particularly concerned, while civil society organisations seem to be equipped with more or less up to date, reliable and fully functioning hardware and IT equipment.

The consultant team reviewed the quality and compliance of the inventory list provided with the generally accepted standard of stock management records. Some institutions had a relatively complete inventory stock system, the inventory lists provided by other stakeholders were sent to the consultant team only after several reminders and after several days / weeks. It is worth noting that these appear to have been made purposely for the request of the assessment and not sourced from an existing stock management file system. No institution provided hard copy of the inventory lists in hard copy signed / stamped by the appointed officers. Only a few institutions could prove to have a solid hardware stock management system including all the information generally recommended as per international auditor standard (i.e. origin, funds, year of purchase, ID number, labels, person responsible officer, physical verification check list, etc). The assessment proves also that there is no consistency between the government institutions on stock records.

Only one stakeholder confirmed that some (but not all) the hardware was insured.
Some interviewees mentioned that often lack of proper maintenance skills and safe storing practices of the hardware (particular from poor weather condition, humidity or temperature fluctuation) represent a serious risk of asset loss and often shortens the life span of the equipment that has been purchased or donated.

Data availability and management

The assessment has revealed that although most of the interviewed governmental and civil society stakeholders are making use of spatial information and spatial datasets, the majority of the available geo-datasets (e.g. topographic maps, geological maps, etc.) are still in analogue format and are currently in the process of being transferred to digital format. The interviews with the experts have also shown that with the exception of singular offices, none of the consulted

departments or agencies have access to, or are making use of Earth Observation (EO)-based remote sensing data, although several online archives (e.g. GLOVIS, etc.) provide free of charge access to time series of low and medium spatial resolution, optical remote sensing imagery (e.g. Landsat) or global digital elevation models of varying spatial resolution (e.g. SRTM, ASTER GDEM). According to the interviewed stakeholders this fact can be primarily traced back to the fact that (i) there is not enough budget for the acquisition of state of the art high spatial resolution or very high spatial resolution satellite imagery and that (ii) the internet connection in the offices is mostly too slow to enable the download of huge datasets, such as remote sensing images.

Besides data availability, the team of consultants has also assessed the data management structures, i.e. existing data storage and backup as well as data updating and meta-data management solutions within the consulted offices. In doing so, the assessment has clearly shown that existing datasets are, with the exception of the National Statistical Office (NSO), the Ministry of Irrigation and Water Development and the Climate Change and Meteorology Department, primarily stored on individual computers not making use of centralised data storage solutions (servers). Moreover, only very few of the visited offices (i.e. the Ministry of Irrigation and Water Development, the Climate Change and Meteorology Department and FEWS NET) were operating professional (e.g. using an automated server solution) or semi-professional (e.g. regular backups using external memories) backup systems. Almost the same picture emerges when looking at the frequency of data updates and meta-data management. Only very few of the visited offices are updating their datasets on a regular basis and almost none of them had meta-data (detailed information about their datasets) for their datasets. This is also reflected in the fact that dedicated positions for creating and updating meta-data are only available at the Ministry of Irrigation and Water Development and the Climate Change and Meteorology Department.

Data sharing mechanisms and institutional knowledge on Spatial Data Infrastructures (SDI)

As indicated at the beginning of this chapter (chapter 3.1.2) the focus was not only set on data availability and management procedures, but also on existing data sharing mechanisms and the institutional knowledge about (national) spatial data infrastructures (SDI). Please refer to box 1

The assessment has shown that all of the consulted governmental and civil society stakeholders are sharing their data free of charge and on request with the Government of Malawi (GoM), including to all ministries and departments in the country. Most of the datasets, however, are restricted to non-governmental institutions, such as private companies, SMEs (small and medium enterprises), academic institutions, etc., who have to purchase the data in order to get full access. Due to lacking availability and capacity to operate web-based services, data is in most cases, if shared at all, transferred via personal contact by CD-Rom, DVD or via E-mail if the file size allows such. So far, only two of the interviewed stakeholders provide free web-based services and free access to their online data archives, i.e. the National Statistical Office (NSO) and FEWS NET Malawi. The following services are provided:

- 'The Malawi Socio-Economic Database' (**MASEDA**, *http://www.maseda.mw/*) which was as created by UNICEF and the National Statistical Office (NSO) in collaboration with Malawi's development partners,
- The 'Integrated System for National Food and Agricultural Statistics' (**CountrySTAT**, *http://www.countrystat.org/mwi*) which is updated by the National Statistical Office (NSO) in close collaboration with the Ministry of Agriculture and Food Security, the Department of Climate Change and Meteorology Services, the Forestry Research Institute of Malawi, the Tobacco Control Commission and the Ministry of Development Planning and Cooperation,
- The 'Famine and Early Warning Systems Network (**FEWS NET**, *http://www.fews.net/pages/country.aspx?gb=mw*) which is operated by the USAID-funded NGO FEWS NET.

Box 1 SPATIAL DATA INFRASTRUCTURE DEVELOPMENT IN MALAWI

ABSTRACT
Spatial data is a key resource for the economic development of a country. There is a lot of economic potential locked away in spatial data collections and this potential is realised by making the data widely accessible and available. Spatial Data Infrastructures (SDI) provide a platform for spatial data users, producers and those that manage it, to distribute the data more efficiently. Through SDI, the available spatial data resources are made available to those that need them to make more informed decisions. Some previous research concluded that more than 80% of decisions have a location component and that makes spatial data key to facilitating the decision making process. Although there has been considerable effort by organisations, such as the Global Spatial Data Infrastructure (GSDI) and the United Nations Economic Commission for Africa (UNECA), to spread awareness of SDI and the important role it plays in national development, their implementation is being done at a seemingly slow pace in Africa, Malawi included.

The Malawi National Land Policy (Sec 16.16.1 b, c, d) clearly stresses the need to have an advisory body that will have a role to help coordinate the creation and maintenance of the National Land Information Management System (NLIMS) and to make arrangements for providing such information to the public and private sectors in a cost effective manner. This was achieved through the establishment of MAGIC (Malawi Geographic Information Council) in 2001. According to the Final Draft of Spatial Data Transfer Policy, 2002, MAGIC was established as a coordination body with responsibilities to oversee the implementation of the spatial data transfer policy 2002 which is still in draft to date. The council had the task to report to the Minister responsible for land matters on progress towards the implementation of the policies. MAGIC operated actively during the first three years after its establishment and later became dormant which has left the data transfer policy unfinished. This paper reviews the history, approach, achievements and current status of MAGIC in Malawi. It is anticipated that the paper will help potential stakeholders to realise and appreciate the importance of SDI and see the need to re-establish the dormant MAGIC.

INTRODUCTION
Spatial Data Infrastructures (SDI) include technologies, policies, standards, and human resources, to acquire, process, store, distribute, and improve utilisation of geo-spatial information. The benefits of SDI have been realised mainly in developed countries where vast quantities of spatial data exist in digital form; data sharing policies are streamlined; internet infrastructure is fast and reliable; and data is comprehensively documented. Several Authors have presented efforts by developing countries to develop spatial data infrastructures, for example, Standley (1997), Economic Commission for Africa (2000), Kalensky and Latham (1998), and Ezigbalike et al. (2000). The authors observe that lack of funds, professionals, spatial datasets, standards, metadata and information sharing policies, are some of the factors hindering the development of SDI's. This has tempted some authors to conclude that Africa and the developing world are not ready for SDI. Although it is evident that the above factors are heavily affecting the rate of SDI development in developing countries, it can also be argued that most of them may be viewed as opportunities. It can be argued equally that acquisition of donor funds to facilitate the capture of spatial datasets in developing countries can create inconsistencies in data formats if not carried out in an SDI framework. Similarly, in Malawi, departments and organisations who create and use spatial data work independently and this has led to circulation of poor quality data and duplications.

Department of Surveys is the National Mapping Agency and mandated by legislation to carry out base mapping and control mapping in Malawi. It is entrusted with the task of geospatial data standardisation. Ineffective implementation of MAGIC has seen the survey dept. failing to fully meet its responsibility. There is a lot of mapping that is done in the country by both the private and public sector without the knowledge of the mapping agency. This has resulted in the use of different data standards by different institutions and donors having funded the same project at different institutions.

DATA COLLECTION METHODOLOGY
Data collection uses a quantitative approach. Data was compiled mainly from interviews with stakeholders and individuals who were directly involved with MAGIC and NSDI, both from public and private sectors, in addition to a review of land policy, Spatial Data Transfer Policy (Draft) and various literature in line with historic milestones of MAGIC and NSDI in Malawi since its initiation in 2001.

THE MALAWI GEOGRAPHIC INFORMATION COUNCIL (MAGIC)

THE HISTORY AND CURRENT STATUS OF MAGIC IN MALAWI
The global trend of adaptation regarding SDI has seen most developing nations like Malawi, significantly lagging behind in their level of implementation of SDI. However many studies like that of Makanda and Smits research (2008) state that one of the biggest failures of SDI implementation in Africa has been attributed to poverty and a strong political barrier bridged by the failure of the professionals behind it to “market” to stakeholders how SDI can be turned into money. Many challenges face Africa today due to the failure of proper use of spatial data in making informed decisions.

Malawi has made in 2001 an attempt to establish a centre very similar to SDI in its objectives. The whole idea arose after the establishment of a project that had Land Resources Department (LRD) as its secretariat. The Project, Malawi Environmental management Programme (MEMP), existed between the years 1994 to 1998. The project had a cross sector approach in its nature which saw it involving different public and private sectors using geospatial data like, Forestry Dept, Water Dept, Meteorology Dept, University of Malawi, just to mention a few. The programme was sponsored by the U.S. Agency for International Development (USAID) and implemented through a partnership between the University of Arizona (UA) and Clark University (CU). The programme introduced GIS in Malawi through capacity building and technical support in terms of equipment and software.

The purpose of MEMP

As initially conceived and finally realised, MEMP was intended to establish capacity within the Government of Malawi (GoM) that would allow them to do two things:

- Provide environmental impact assessments to evaluate outcomes of proposed policies. The information generated could be used to reform existing policies, or create new ones, that could be supported through non-project assistance.

- Perform environmental monitoring and assessments of changing conditions to target and shape mitigation efforts. These would be identified as opportunities that could be supported and achieved through direct project assistance.

Outputs of MEMP

The achievements of MEMP are characterised in three parts:
Capacity Building in GIS - Between 1994 -98 MEMP successfully provided annual training to approximately 20 participants each year.
Products - MEMP's GIS training has resulted in the development of a number of environmental monitoring products. These include land use and land cover maps for the Shire watershed, soil erosion maps for the Shire watershed, monthly rainfall surface maps at the Meteorology Department, the digitising of the Land Resources Evaluation Project (LREP), soils map at the Department of Surveys and Land Resources Conservation Department, and the digitising of the national 1:50,000 and 1:250,000 map series at the Department of Surveys.
Expertise - Perhaps the most important accomplishment of MEMP's GIS training component has been the development of a core group of dedicated and capable in-country environmental analysts for environmental monitoring. Approximately eighty individuals were trained.

The gateway of MEMP saw the birth of two independent NGOs, Land Resource Centre (LRC) and Total Land Care (TLC). It was therefore realised that there was need for a coordinating committee to take care of geospatial data produced under MEMP. The idea led to the birth of Malawi Geographic Information Council (MAGIC) in 2001. MAGIC, as a council, comprised of heads of institutions working with spatial data in Malawi, such institutions included Surveys Dept (DoS), National Statistics Office (NSO), Forestry Dept, Land Resources Dept., Meteorology Dept., Water Dept., Chancellor College, Lands, Environmental Affairs and the then prominent projects such as FEWS NET. As clearly stated in the Malawi National Land Policy, 2002, sec 6.16.1.b, the ministry responsible for land shall coordinate the establishment of the Malawi Geo data Coordinating Committee composed of senior representatives, Department of Surveys (Surveyor General) was chairman of the council.

Role of MAGIC

According to the Final Draft of Spatial Data Transfer Policy, 2002, MAGIC as a coordination body had responsibility to develop and oversee the implementation of policies as drafted in the National Spatial data transfer Policy, 2002 and report to the Minister responsible for land matters on progress towards that implementation. MAGIC had a task to coordinate and monitor implementation of activities and take responsibility for ongoing management of the policy, drawing upon the resources from government core funding and nominal fees through the sale of data and/or GIS services.

For the model to work effectively, MAGIC needed to make a commitment to:

- ❑ Develop and maintain a data access point and monitor its performance and efficiency;
- ❑ Regularly audit the quality of the metadata provided to the access point, encourage agencies to improve it, provide a status report to the management board of MAGIC; and
- ❑ Regularly audit the availability and quality of framework data.

Custodian responsibilities

For the model to work effectively, the custodians of data must have a commitment to:

- ❑ Create or request assistance to maintain good quality metadata to ensure that the discovery mechanisms work well;
- ❑ Ensure that the link with a data access point is maintained and that the metadata and datasets are accessible;
- ❑ Continually review the conditions under which individual datasets are made available; and
- ❑ Ensure that new datasets are added to the data schedule and redundant ones retired.

NATIONAL SPATIAL DATA INFRASTRUCTURE (NSDI)

The National Spatial Data Infrastructure (NSDI) is a centre established in 2002 that was put in place by MAGIC to implement its policies (draft). The centre was designed as a pool of all the spatial data information in the country that will be accessible to everybody. All the digitised data from MEMP was put under the control and management of this centre. NSDI's operations were not practically independent from Department of Survey since it used primarily the Department's premises and personnel. The centre manager officer and three technicians were seconded from the Department to NSDI.

Between 2003 and 2004, MAGIC recruited a group of consultants in a different field to quick start the operations of the NSDI. The experts had a task to analyse and make recommendations on the set up of the centre. The field of expertise of the consultants included IT, human resource, GIS and finance. The team was, at the end, expected to develop an organigram of staff, an approach to allow the centre to operate as a business organisation since it was expected that NSDI should be able to generate money for its operations. After a period of six months the consultants produced a report which had the following recommendations:

- Make NSDI an autonomous centre where positions will be competitive. The staff organigram was developed.
- Create ways of making NSDI a self sufficient organisation financially i.e. service provider, selling GIS data etc.
- Creation of metadata.
- Creation of data standards.
- Copyright protection.
- Use of web GIS to make Malawi spatial data accessible both at local and international level.

All the initial operations of NSDC were funded by government. In 2002, NSDC signed a one year contract with the European Union (EU) who only provided technical support. The support was in the form of equipment and technical experts to make sure the recommendations by consultants were being implemented. After the expiration of the contract with EU, between 2005 and 2006 there was no donor, however EU expected another proposal for additional funding, this was never submitted. Since NSDC had climate change components, they received interest from FAO and UNDP to fund their activities, but during that time it was dormant. MAGIC and NSDI have since 2007 become inactive which has made it fail to:

- Finalise data transfer policy
- Establish legal frame work of MAGIC/NSDI
- Formalisation of data standards
- Development of data catalogue

CHRONOLOGICAL ORDER OF EVENTS

PERIOD	EVENTS
1994 - 1998	Malawi Environmental Management Programme (MEMP)
2001	Initiation of MAGIC
2002	Establishment of National Spatial Data Infrastructure (NSDI)
2002	One year contract with European Union
2002	Draft of data transfer policy
2007 to present	MAGIC/NSDI no activities implemented

CHALLENGES OF MAGIC/NSDI

Failure to implement the recommendations by consultants, highly affected the implementation of MAGIC policies as regard to geo spatial data in Malawi. There is no policy relating to SDI to date. The 2002 data transfer policy and the Malawi Digital Data Standards (MDDSs) are still in draft form and it is hoped that once MAGIC is active again they will be finalised. Some of the major problems faced by MAGIC were, according to those interviewed, as follows:

- *Lacked legal framework*
  The centre was not legalised, it was operating informally within Department of Survey. It was therefore difficult to run. This made it difficult for the centre to have independent staff since it was not properly institutionalised. The proposal to have it institutionalised was developed for parliament to approve, and it is therefore believed that once the bill passes, things will progress, but there is no assurance of success. According to the Land Policy sec 16.16.1 the centre was supposed to be established as a legal entity with clearly defined functions, powers and a mandate formalised under the Land Surveys Act.
- The centre was significantly attached to one department and the other departments were hesitant to work with the centre.
- *Availability of resources*
  The NSDI did not have enough finance and staff working for NSDI. The few staff dedicated to NSDI received their salaries from the Government. These employees were already committed to the Survey Department tasks. Therefore it was difficult for them to fully dedicate the necessary energy and competences to develop appropriate proposals aimed to attract funds from other donors. Consequently the lack of resources and activities related to the development and progresses of the NSDI coupled with staff turnover contributed to the weakening of interest from various stakeholders.

CONCLUSION AND RECOMENDATIONS

In this section we report the conclusions and suggested recommendations of the various interviewees. The recommendations of the consultant team are reported in chapter 4.

Some of the problems encountered according to various interviews conducted, included no copyright protection laws for geographical information system data; no laws on interdepartmental data access and exchange and this is creating gaps in decision making, and lack of geospatial data accuracy standards, just to mention a few.
It is still felt as a big necessity both in public and private sectors, especially those in the industry, to revamp a well structured SDI in Malawi.
The interviewed stakeholders recommended as follow:

- The interviewees all recommended to revamp the efforts to activate the MAGIC and the NSDI
- There is need to change strategy. The centre needs to be autonomous; it must operate independently from any government department in terms of administration and staff members. However a strong link and regular exchanges are necessary from the MAGIC members, particularly the Survey Department. Government departments, being data custodians, ''must be fully involved but not take lead, rather just be active members (stakeholders)''. Training institutions should work together with NGOs to re-establish a functional SDI centre following working examples both at international and local level. Some plausible working examples have been indicated by some interviewees from the academic institution in Malawi. Among them are the following: a) the African Regional Centre for Space Science Technology Education (ARCSSTE), a training and research centre operating within Obafamemi Awolowo University; b) LEAD, a research centre, and Lake Chilwa project working within Chancellor College; c) the Centre for Geoinformatics (Z_GIS), a research centre working within Salzburg University in Austria, having the independence and capacity to attract funds and develop research and implementing project. All these centres have their administration operating independently from the University they are attached to but highly utilises their wide range of technical expertise. Training institutions have the powers to set up centres that can operate independently and easily gain public recognition.
- Fully gain the interest of policy makers in Government. ''Data policy'' is a government policy and there is need to fully involve government. As previously mentioned, the geospatial data sets are owned by government departments, these departments must be fully involved. Only by having the policy fully adopted can the NSDI be empowered to function efficiently.

Application domains of GI technology

In accordance with the respective mandates, missions and capacities of the consulted national stakeholders the application domains where GI technology is utilised comprise the following fields and sectors:

- Agro-meteorology (drought monitoring),
- Catchment management services,
- Census mapping and household surveys,
- Forestry (biodiversity, land cover mapping),
- Geology (geological mapping and mapping of earthquake-prone areas),
- GPS surveys,
- Hydro-graphic surveys (water levels at lakes),
- Land services (i.e. cadastral services),
- Landslide mapping,
- Topographical mapping,
- Monitoring of food security and related weather hazards (flood, drought).

The assessment revealed that, due to lacking resources and capacities, no explicit mapping of hazard-prone and hazard affected (post-event mapping) areas and related vulnerabilities, including the vulnerability domains (i.e. physical, ecological, social, economic, cultural and institutional) at different levels (local, sub-national, national) have been carried out so far.

Training and Research Institution

The study identified two local private GIS training consultancy firms and one international GIS and RS service company from South Africa that offer and already provided a number of training to government department staff in Malawi in the last 5 years. Occasional special trainings were provided to government staff outside Malawi. For instance, recently (2011) a training on applied Remote Sensing for mining services were provided by the Japan Oil Metal National Corporation to five staff members of the Geological Survey Department (3 weeks in Japan and 2 Weeks in Malawi).

We did not identify any private school and or permanent private dedicated GIS and or RS training institutions based in Malawi.

The academic institutions in Malawi offering GIS and RS as courses include Mzuzu University, The Polytechnic, Chancellor College and Bunda College of Agriculture. These institutions were interviewed during this study. All the institutions established these courses very recently with the last 5-7 years. In some of these institutions the courses are offered both at BSc and MSc level while others its only at BSc. Some institutions have well qualified lectures in RS and GIS with MSc and studying towards PhD. Due to high financial demands attached to RS and GIS, there are several hindrances that these training institutions are facing.

Some of the major challenges these training institutions are facing include:

i. Limited availability of trained staff and lack of practical laboratory
   The current numbers of lecturers is outnumbered by the increasing number of courses and relative students in different disciplines who require courses in RS and GIS. The number of available stuff does not match the requirements. In some of the institutions the lecturers are not fully qualified to teach both RS and GIS or are qualified only in one or another course or have a limited practical experience.
   Often the training have a relative good theoretical profile, but some courses lack of sufficient practical exercises preparing all the students to actually master the GIS and RS

software. This is partially due to the expertise / qualification of the lecturer or to the inadequate resources offered by some of the institutions

ii. Inadequate recourses to afford high cost of technology and associated and appropriate maintenance practices:
    - The institutions do not have enough funds to purchase software for RS and GIS this has seen most of them using out of date software eg. ArcView 3.2, trial versions which are not reliable. Some are using educational licences but not have the full software extensions necessary to provide the comprehensive education package.
    - They have severe problems in term of necessary infrastructures. The IT rooms available are often either too small to accommodate large numbers of students attending the course. In the majority of institutions the computers are not enough and often too old and or damaged to be used with the new software. Similarly there are inadequate printing and copying facilities. Most of the institution declared having problem with virus management due to lack of maintenance due to inappropriate IT habits practice and /or lack of available funds to purchase and maintain anti-viruses.
    - Often power blackout affect the lectures since the institution either do not have generator (or fuel for it) and or power stabilizer (with consequence damages of the IT equipment)
    - Lack of enough funds to purchase RS and GIS data.
    - Insufficient and unrealisable Internet. The majority of institution declared to be dependant on external donation to ensure Internet connectivity. Often some could not ensure constant Internet services to the whole student community.
    - Difficulties in finding partnership with foreign universities as regard to RS and GIS. Out of the four institutions interviewed only one has an official partnership with a foreign university but the partnership is almost expired and it is not certain on the possibilities to renew.
    - Data backup systems. Absence of a data management plan including automatic data back up and development / updates of meta data. All the interviewed training institutions uses CDs and DVDs for backups. They do not have a well set IT systems where data is backed up using servers. Again they do not have external hard drives.

Three of these institutions were directly involved with MAGIC. Some institutions have managed to develop and implement remarkable research works using RS and GIS tool. The researches include those done by the institution and some conducted by individual researcher within the same institution without being an official research program of the university. Some of these researches are relevant to CCA and DRR. The information as regard to individual research work was not fully provided since each one of them was supposed to be contacted in person and it was difficult to do so as some were outside the country and some were out in the field. Among the few that were contacted in some two interviewed institutions have done research on:

- Participatory GIS in Liwonde-Mangochi Complex
- Risk assessment of floods in the Lower Shire area
- Lake level and palaeoclimate reconstructions of the Lake Chilwa area – a multi-proxy approach
- Location of Landslides in Livingstonia, Rumphi District

Only two institutions from the four interviewed has managed to do research on:

- Participatory GIS in Liwonde-Mangochi Complex
- Mapping All EU Projects in the Northern Region of Malawi
- Mapping of Shallow wells in the Locations of Mzuzu city
- Mapping of water locations and pit latrines in Mzuzu City

Currently at least one individual research done by a lecturer of one of the research /training institution involve land use and land change use in the central region.

One of the training institutions has been conducting short courses in RS and GIS for government officers in the past. However for the past two years they have not done any training due to limited funds and human resources as most of their staff in RS and GIS are doing PhD outside the country.

However we could not trace any direct link or direct knowledge about these studies within the CCA committee and or DODMA and this lead to the conclusion that most of these studies wee conceived by a pure academic motivation and not part of a synergism between government department needs and the academic world.

In summary we can state that in Malawi the training / research institutions made a tremendous effort to incorporate and upgrade their curricula the GIS and RS. The increased demand from the student to learn about GIS is a positive consequence of the sensitization and education provided at various level. The efforts to meet this demand are commendable and offer the appropriate platform to continue growing the technical expertise within Malawi. However financial limitations are indeed a serious threaten to keep up to date the training power and satisfy the increase demand of the market and the government's need of local GIS and RS experts.

Considering the technology the world is using RS and GIS must be well strengthened where academic institutions have a very big role to play. It was therefore recommended by the interviewed training institutions that a 'GIS /RS Centre should be established' which will support and network the RS and GIS activities in training institutions and Government departments. Having the centre deployed will help solve some of the challenges the institutions are facing. In this sense, one of the roles the centre must have is to source funds for RS and GIS operations and promote partnership as regard to RS and GIS between Malawi training institutions and those from developed countries.

Some of the details recommendation inputs are incorporated in the chapter 4 of this report.

3.1.2.2 District level

Even more than at a national level, the district level stakeholders being involved in DRR and CCA activities reveal an enormous lack of Geo-Information capacities, awareness and tools.

Governmental institutions

During the assessment at a sub-national level, it became clear that most governmental institutions at district level are not familiar with GIS or remote sensing software and the potential of GI for CCA and DRR due to a lack of (i) training of the local technicians, (ii) hardware and (iii) software. Moreover, as a result of the general situation in the country, economic resources in governmental organisation are scarce and the situation in the local districts is even worse. Specific tools for GI are not available and IT equipment is generally scarce or obsolete.

Non-governmental institutions

Within non-governmental organisations there is a raising of awareness about the potential of GI for DRR and CCA; but the operational capacity is nonetheless still very low. Some of the technicians have capacities in GIS, but the level is too low to set up and maintain a geo-database or to conduct sophisticated spatial analyses. The assessment has shown that within NGOs geo-data is available in some cases, but that there is no capacity to organise, update and to share data making use of state of the art technology. Specific GI tools and related equipment are not available in the majority of the consulted NGOs. The same applies for both commercial as open-source GIS and remote sensing software.

3.1.3 Gaps and needs

Besides assessing existing GI for DRR and CCA capacities, another focus was also set on prevailing gaps or limitations and needs which the consulted key governmental institutions, international and civil society organisations are facing in terms of (i) financial resources, (ii) expertise, (iii) knowledge, (iv) hardware, (v) software, (vi) data, (vii) maps and (viii) other factors that are required to successfully contribute to the development of long term climate change adaptation tools. Figure 3 shows the importance of the gaps that were raised by the experts during the semi-structured interviews. As in Figure 2 the size of the letters represents the importance, or more specifically the frequency that specific gaps or limitations were mentioned. It becomes obvious that the following factors are the key issues that were identified as most prevalent **gaps** by the stakeholders:

- **data** (lacking data availability and inadequate data management solutions and data sharing mechanisms),
- **hardware** (insufficient, broken or out of date hardware/devices),
- **software** (inappropriate number of official licenses, out of date versions)
- **training** (lack of basic training in GIS and remote sensing, but also concerning dedicated knowledge how to use GI technology for DRR and CCA),
- **financial resources** (particularly for training and to purchase state of the art hard- and software as well as 'expensive' datasets, such as satellite imagery).

Figure 3: Identified gaps within the consulted offices

During the assessment it became evident that most of the consulted government institutions face almost all of the listed gaps and limitations at the same time, while civil society organisations were mostly confronted with only one or two of these gaps (i.e. primarily their existing data management procedures).
Based on the identified gaps and limitations that the experts and their departments or agencies are facing they were also asked to name their most important **needs** in terms of strengthening or fostering existing GI capacities. A ranked summary of the most important needs that have been stated by the interviewed experts are displayed in Figure 4. Again, the size of the letters represents the importance or the frequency that specific needs were mentioned. Figure 4 clearly shows that, while the gaps and limitations are quite diverse, the needs primarily concentrate on:

- **training**, including (i) basic and advanced training in GIS, remote sensing, GPS data collection and analysis and data base management (DBM) as well as (ii) specialised training how to utilise state of the art GI technology in the field of DRR and CCA,
- **data** (data availability, data management solutions and data sharing mechanisms),
- **financial resources** to purchase **adequate equipment**, including hard- and software.

Figure 4: Identified needs of the consulted departments/agencies/offices

3.2 Evaluation of existing Early Warning Systems (EWS) in the country

Besides, assessing existing hazard and vulnerability mapping expertise and capacities a second objective of the presented study was to provide an overview of **available Early Warning Systems** (EWS) in the country and to critically evaluate their effectiveness, strengths and weaknesses as well as potential strategies for the improvement and up-scaling of these systems. Therefore, the following chapters present an overview and critical discussion of currently existing state-run and community-based EWS in the country.

Box 2 Early Warning System Definition

UNISDR develop basic definitions on disaster risk reduction to promote a common understanding of the subject for use by the public, authorities and practitioners.
The terms are based on a broad consideration of different international sources. The following definition of Early Warning System is given by ISDR and reads as follows:

The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organisations threatened by a hazard, to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss.
Comment: This definition encompasses the range of factors necessary to achieve effective responses to warnings. A people-centred early warning system necessarily comprises four key elements:

1. *Knowledge of the risks (Vulnerability & Hazard)*
2. *Monitoring, analysis and forecasting of the hazards;*
3. *Communication or dissemination of alerts and warnings;*
4. *and local capabilities to respond to the warnings received.*

The expression "end-to-end warning system" is also used to emphasise that warning systems need to span all steps from hazard detection through to community response.
The current report therefore recognises the above definition for EWS.
Available at: www.unisdr.org/we/inform/terminology

3.2.1 Early Warning Systems (EWS) in Malawi

3.2.1.1 National early warning structures

This chapter provides an overview of the existing Early Warning Systems and structures which are maintained and operated at national level. The following sections present the national flood, food

security and wildfire early warning systems, highlight their overall workflow and critically discuss their strengths and weaknesses. These are the major hazards identified and notified by the interviewees. Other hazards such as tsunami, strong wind, other, were also investigated by the consultant team but are generally omitted because during the interviews no substantial information were provided regarding relative EWS to these specific hazards. Concerning the earthquakes the Geological Survey Dept. only mentioned the existence of stations with seismographers used as scientific monitoring tools but does not fit into the full definition of an EWS with all its elements.

National Flood Early Warning System (F-EWS)

Figure 5 shows the structure of the **national Flood Early Warning System** (F-EWS) which is maintained and operated jointly by the Department of Climate Change and Meteorological Services, the Ministry of Irrigation and Water Development and the Department of Disaster Management Affairs (DoDMA). The flash-points represent potential faults in the system according to the interviewees.

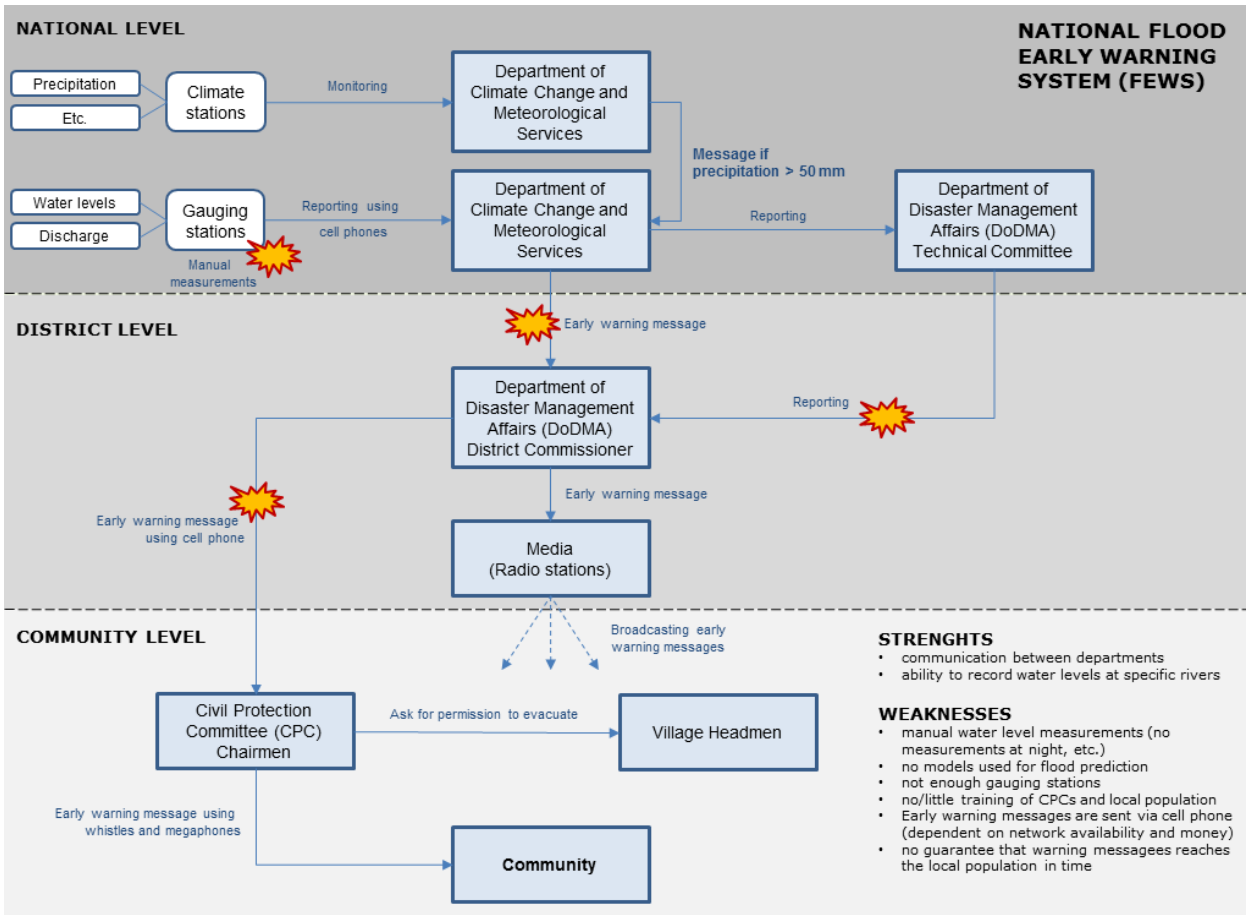


Figure 5: National flood early warning system (F-EWS)

The Department of Climate Change and Meteorological Services operates a set of meteorological stations comprising 22 full meteorological stations, 21 subsidiary agro-meteorological stations and over 400 rainfall stations all over the country. Figure 6 shows the location of the main meteorological stations.

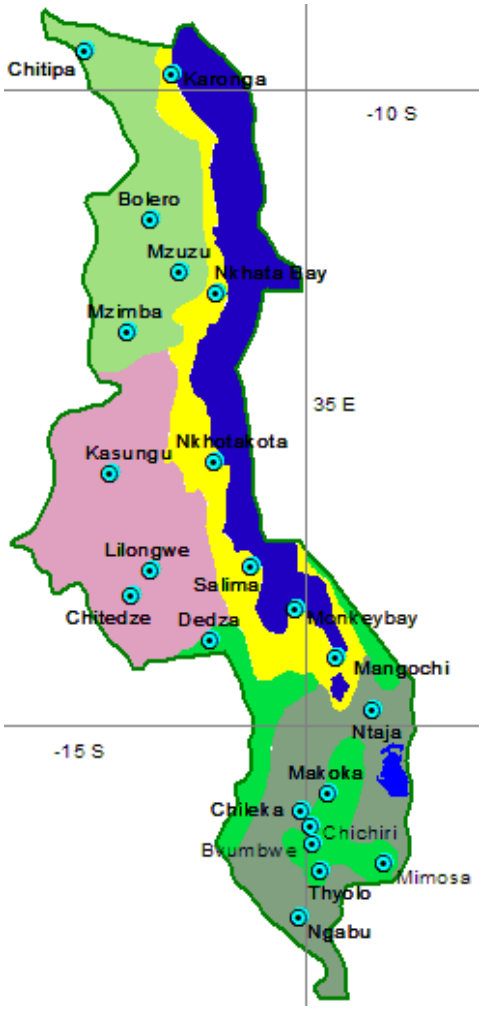


Figure 6: Main meteorological stations (Source: Department of Climate Change and Meteorological Services)

According to the Department of Climate Change and Meteorological Services observations at the 22 full meteorological stations are done by trained meteorological assistants regularly at 05:00, 06:00, 08:00, 09:00, 11:00, 14:00 and 17:00 local time. Thereby, the minimum number of observations per station is two at one-man stations and only on Saturdays and Sundays. Currently, two stations are doing observations 24 hours a day. As soon as precipitation values of more than 50 millimetres are observed at one of the meteorological stations, a warning message is sent to the Ministry of Irrigation and Water Development, which itself operates a number of gauging stations in some of the major rivers in the country providing information on water levels and water discharges in these rivers. A warning message is then sent from the Ministry of Irrigation and Water Development to both the Technical Committee of the Department of Disaster Management Affairs (DoDMA TC) and the DoDMA district commissioner in the respective district/s. The district commissioner forwards the message to the local media (i.e. primarily radio stations) and the chairmen of the Civil Protection Committees (CPCs) in flood-prone communities. Early warning messages are then broadcasted via radio and by the CPC members using whistles and megaphones. However, note that before villages at risk can be evacuated by the CPCs the local CPC chairman has to ask the village headman for his permission to evacuate.

Thus the F-EWS reveals the following **strengths** according to the interviewed experts:

- there is a strong institutional link between the departments involved in F-EW activities,
- the availability of gauging stations in some of the major rivers enables the monitoring of water levels and discharge in at least some rivers.

However, there are also distinct **weaknesses** that were mentioned by the experts:

- although being conducted by trained personnel, the measurements at the gauging and rainfall stations are still manual, resulting in no measurements being taken during the night,
- to date no models are used for flood forecast and prediction,
- many rivers in the country are still lacking gauging stations, disabling the provision of early warning messages by the responsible departments for wider regions,
- so far neither the CPCs nor the local population in flood-prone areas have been properly trained how to react when a EW-message is received (only selected communities have been trained by civil society organisations involved in DRR activities),
- early warning messages are not sent automatically, there is no standardised approach as to when and how to send EW messages. Currently EW-messages are sent via cell-phone, making successful information dissemination dependent not only on network availability but also on the availability of credit on the respective phones. This means that there is no guarantee that the local population can be warned in time.
- in the southern part of the country (i.e. particularly in the lower Shire basin) flooding is sometimes caused by heavy rainfall in Mozambique. The existing F-EWS is not prepared to deal with these cases as there are currently no cross-border meetings of relevant stakeholders.
- Recently significant funds were disbursed by a donor to purchase new weather stations and water gauge stations, however the interviewees gave the clear impression that there was little or no communication about this action with the DODMA.

National Food Security Early Warning System

Figure 7 shows the structure of the national **Food Security Early Warning System** which is maintained and operated by the USAID-funded FEWS NET (Famine and Early Warning Systems Network) country centre in Malawi.

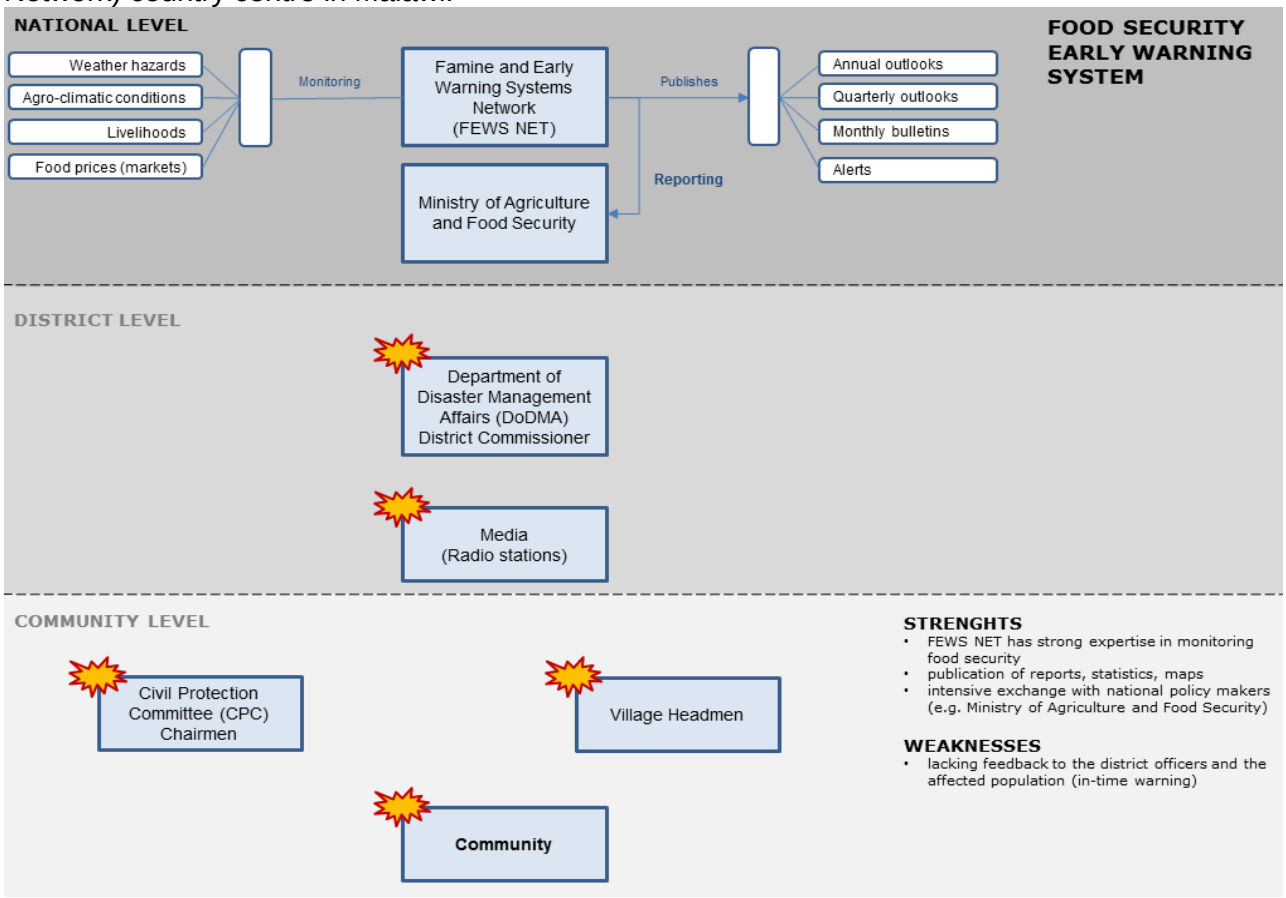


Figure 7: National Food Security Early Warning System

According to their mandate, FEWS NET monitors and analyses relevant data and information in terms of its impacts on livelihoods and markets to identify potential threats to food security. This comprises (i) a weather hazard impact assessment (i.e. a weekly assessment of current weather conditions and their impact on food security), (ii) remote sensing-based agro-climatic monitoring, (iii) the production of livelihood baseline and livelihood zone profiles as well as (iv) a comprehensive market review (i.e. food prices, markets and trade). In terms of dissemination FEWS NET uses several communication channels and decision support tools to help decision makers to mitigate food insecurity. These tools include monthly food security updates, regular food security outlooks, and alerts, as well as briefings and support to contingency and response planning efforts.

Thereby, the FEWS NET approach reveals the following **strengths** according to the interviewed experts:

- FEWS NET has a strong expertise in monitoring drought, floods and related food security issues,
- FEWS NET provides policy-oriented information on food security using state of the art technology on a regular basis (quarterly outlooks, monthly bulletins, etc.),
- FEWS NET makes use of state of the art web GIS-based solutions to inform policy makers, the public and the media about food security related issues.

However, there are also some distinct **weaknesses** that were mentioned by the experts:

- FEWS NET has strong links to policy makers (e.g. Ministry of Agriculture and Food Security), but the feedback to the local (affected) population is very limited and not on a regular, standardised basis.

Box 3 MALAWI VULNERABILITY ASSESSMENT COMMITTEE – MVAC

Malawi, like many other African countries, is suffering from the effects of climate change that have caused hazards and disasters to occur more frequently. The most common hazard experienced, almost every year in Malawi, is flooding. This mostly affects the districts of Salima, Nsanje, Chikwawa and Karonga. Dry spells and droughts are very common, mostly in the districts of Nsanje and Chikwawa. Disasters cause avoidable and unnecessary death and property damage that could be significantly reduced with effective early warnings. It is for this reason that the government of Malawi established MVAC (Malawi Vulnerability Assessment Committee) to take responsibility in disseminating early warning information to the Government for policy making and for NGOs to identify necessary interventions. MVAC is an early warning information centre in Malawi operating at national and regional (SADC) level. MVAC provides early warning information to the Government and other stakeholders to make decisions and put in place necessary interventions.

MVAC was established in 2003 with the aim of providing early warning information to the government as a policy maker and other stakeholders. MVAC comprises of inter-government; academic and non-profit member organisations that seek to provide information to inform public action. Participating MVAC members include: Ministry of Development Planning and Cooperation, Ministry of Health and population services, OPC Department of Nutrition and HIV and AIDS, Ministry of Agriculture and food security, Department of Disaster Management Affairs (DoDMA), Ministry of Finance, The National Statistics Office, NGOs in food security and humanitarian interventions, Save the Children, World Vision, Catholic Relief Services, Bunda College of Agriculture, FEWS NET,UN Agencies (FAO, UNDP, UNICEF, WFP) OXFAM and other development partners. The MVAC secretariat is funded by the Government of Malawi and the British Department for International Development (DFID) with technical and administrative support from Save the children. Additional funding is received from the European Union (EU) through the Technical Secretariat of the Food Security Joint Task Force in the Ministry of Agriculture and Food Security.

MVAC has a responsibility to provide accurate and timely transitory vulnerability information for effective policy and programming to benefit the most vulnerable. MVAC share their information at regional and national level. The information is disseminated through reports that are produced annually in July and November. According to MVAC strategic plan (2010 – 2015), MVAC is mandated to assess food security and livelihood vulnerability for timely and accurate early warning information to inform policy and programming in Malawi. In pursuit of this, MVAC seeks to:

- Sustain linkages to MGDS through social protection, social development and sustainable economic growth.
- Provide timely and accurate information on the level of food security and vulnerability in terms of population with missing food entitlements and level of missing food entitlements.
- Provide training in vulnerability assessment and analysis
- Dissemination of information for policy making and programming to relevant groups such as Government institutions, development partners and NGOs.
- Strengthen the regional vulnerability analysis and participate in the regional VAC

Some of their information is collected at a regional level with the use of satellites. FEWS NET has the task to follow up on prices of food products as one of the indicators, hence the information is incorporated to assess vulnerability.

According to the response from the interviews made, since it was started in 2003, MVAC has always provided the nation with accurate early warning information, i.e. 90% if rated, however it encounters some challenges. Among these are:

- Capacity to use GIS as a tool - According the MVAC officers interviewed, MVAC staff has 'low capacity' to use Geographic Information System (GIS). They depend on experts from the regional office. According to those interviewed they recommended a comprehensive training in GIS for MVAC staff members.
- 'Donor fatigue' - Gathering information is an expensive task to carry out, and it therefore depends on its cooperating

partners.

CONCLUSION and RECOMMENDATIONS

As mentioned this report focuses on the Mapping and use of Geo Information management of the EWS and therefore it is not in the intentions of this report to analyse the scope and the role of MVAC.

Interestingly, none of the interviewed officers from the other institution mentioned MVAC as EWS during the interviews (except one agency during the workshop held on the 4th of October 2011). Someone may interpret it as an indication that various institutions perceive MVAC more as a vulnerability information tool more than an EWS. This is probably associated to the fact that MVAC does not directly act on the fourth element of a complete EWS to equip 'local capabilities to respond to the warnings received' (refer to the box EWS Definition). In fact, based on the academic definition suggested by ISDR standards, an early warning system is a set of capacities needed to generate and disseminate timely and meaningful warning information to *enable individuals*, communities and organisations threatened by a hazard to prepare and to act appropriately in sufficient time to reduce the possibility of harm or loss. Based on this dimension, the MVAC is indeed an early warning information agency since it is able to provide timely and accurate early warning information. It is noteworthy that lack of 'direct' capacity building at a local level to respond to the message received' was also remarked for other EWS considered as indicated in this report. The role and usefulness of MVAC is undoubtedly crucial in Malawi to provide a clear food security related vulnerability analysis.

The lack of comments and knowledge of MVAC reports observed at various District level, both from District authorities and international agencies, suggests that some efforts should be made to further disseminate the reports and support the District government offices to use it as a decision making tool.

The use and dissemination of MVAC reports could be increased if the data were presented on an interactive online Web GIs database. Ideally the MVAC reports should be integrated in a more comprehensive Web Gis Atlas designed to monitor hazards and vulnerabilities (please refer to the section below related to the recommendations related to EWS).

Earthquakes

The Geological Survey Department referred directly to earthquakes mentioned the existence of monitoring stations with seismographers disseminated in strategic locations in the country. Other interviewees provided only marginal information and reported to have no confirmed information about any EWS for earthquakes. The seismographers are used above all for scientific reasons and measure the magnitude of seismic events, but only partially can be used determine the potential risk of earthquakes. The information are collected I a semi automatic way and processed by the same geological Survey Department. We could not verify how the data are kept and disseminated, but the department reported that in case of hazard the information could be disseminated previous request. The typology of data collected is certainly one of the most important for a potential EWS, but the overall system of data transmission and way of processing does not fit into the full definition of an EWS with all its elements. The geological survey department did not provide the consultant with an updated map of these locations. An important step forward would be to integrate the data collected by these seismographers in real time using wireless and full-automated transmission to a Web Atlas platform (see recommendation below)

Wildfire Early Warning System

Figure 8 shows the structure of the **wildfire early warning system** which is maintained and operated by the Department of Forestry to protect the state-owned forest plantations.

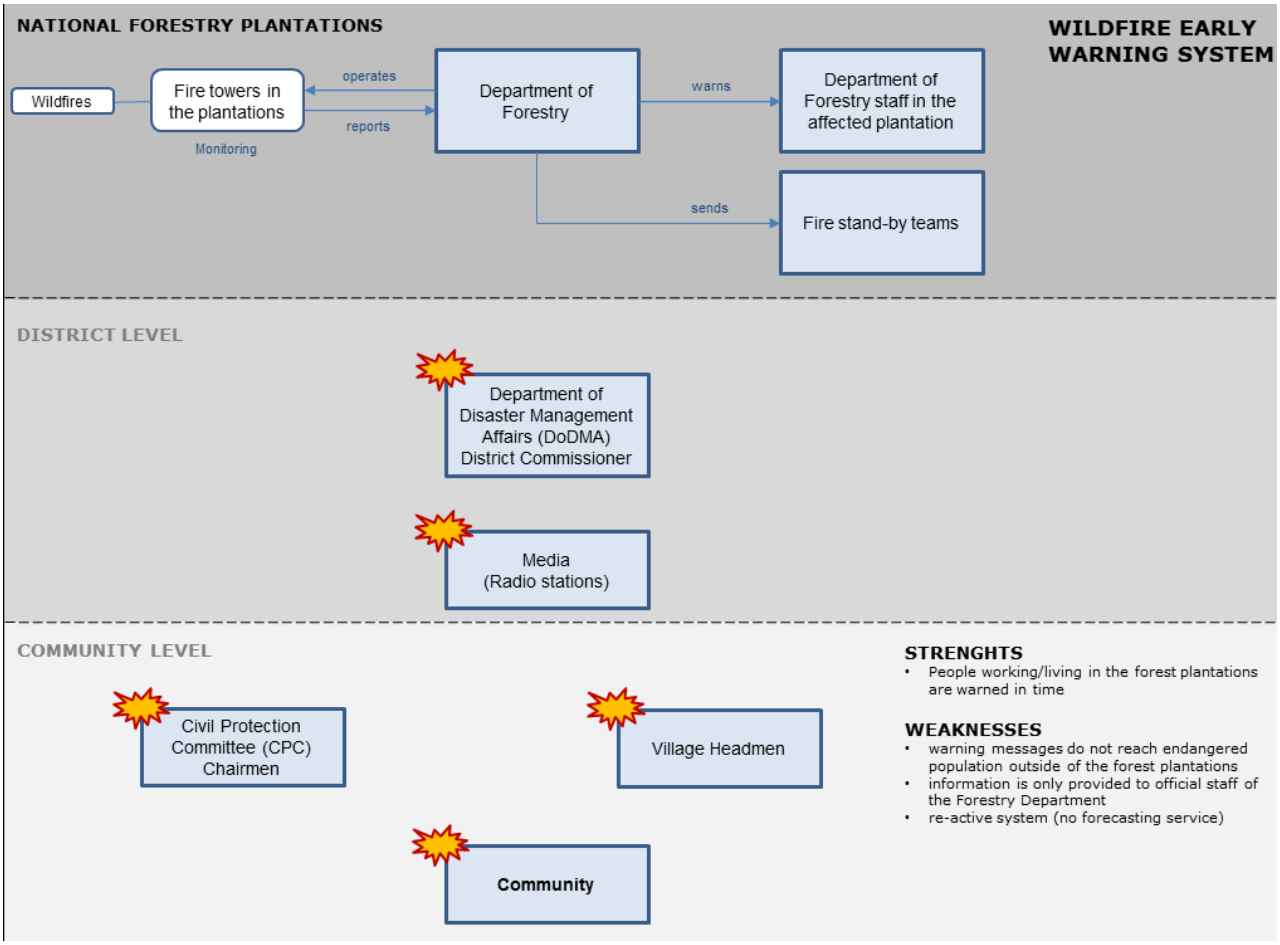


Figure 8: Wildfire Early Warning System (forest plantations)

In order to protect the state-owned forest plantations from damage caused by wildfires, the Department of Forestry is operating a number of fire watchtowers in its plantations. Once a wildfire is observed by the fire watchers, the Department of Forestry sends a warning message to their staff working on the affected plantation and sends fire stand-by teams in order to mitigate damage to the plantation. One of the strengths of the system is that people living or working in the affected plantation are warned in time. However, the warning message does not reach the people living in the vicinity of the plantations or outside of state-owned plantations, the warning message only being sent to official staff of the department.

3.2.1.2 District and community-based EWS structures

This chapter provides an overview on the existing early warning systems (EWS) at District level.
The EWS discussed in this section are the ones identified during the documents review and by the interviewees. The latest indicated only 3 districts having some kind of EWS in place: Nsanje, Chikwawa and Salima. The assessment team visited therefore these 3 districts and carry out the assessment in 2 other districts: Kasungu and Karonga. These two districts were selected because they were already identified by the Climate Change Committee and DODMA as hazard prone areas. The field data collection included an interview with the I Director of Planning and Development (DPD) and/or the local DoDMA officer in all five districts and the NGOs teams currently supporting the adoption of the EWS in Nsanje, Chikwawa and Salima. The consultant team met the local committees involved with some of the EWS station and collected geographic coordinates using GPS for all the points visited.
This report is not intended to be a comprehensive analysis of all the aspects of EWS in Malawi, neither was it within the scope of the study to compare and grade the various institutions. The

purpose of this section is to give a brief overview of the functionality of the various EWS identified during the assessment and to discuss their strengths and weaknesses and formulate a series of practical recommendations for the possible adoption of GI within EWS related plan in Malawi linking district and central level.

General overview on the Early Warning System identified

Tables 10 to 12 indicate the sites visited and some technical aspects related to the EWS in each district.

NGO: Goal Malawi

Funds: ECHO

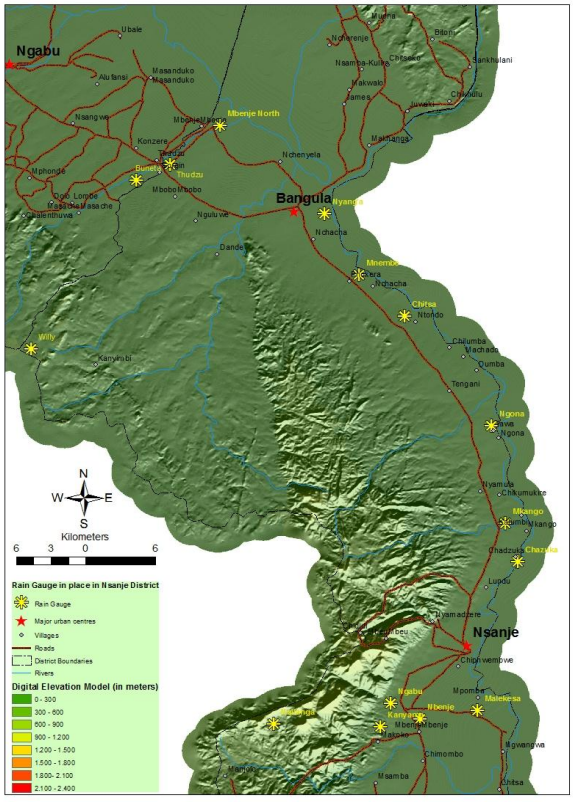
Intervention time frame related to the EWS 2008 - 2011

Activities conducted: rehabilitation of the rain gauges and their use as EWS stations, organise and train the local Civil Protection Committee in collaboration with the DODMA officer on DRR, other related DRR activities.

Typology: A Rain Gauge is used by the communities to monitor the flow and quantity of water. The rain gauge consists of a funnel attached to a graduated cylinder that fits inside a larger outside container. If the water overflows the inside graduated cylinder, the outside larger container will catch it. The alert is given according to the rainfall quantity. Hydrometric measurements of water surface elevation ("stage") are simplified by colours on a bar in order to give a fast signal to the people in charge of monitoring it. Green colour means there are no risks, yellow means alert and activations of evacuation procedure and the red means consolidate flooding state.

Means of alert communication: cellphones.

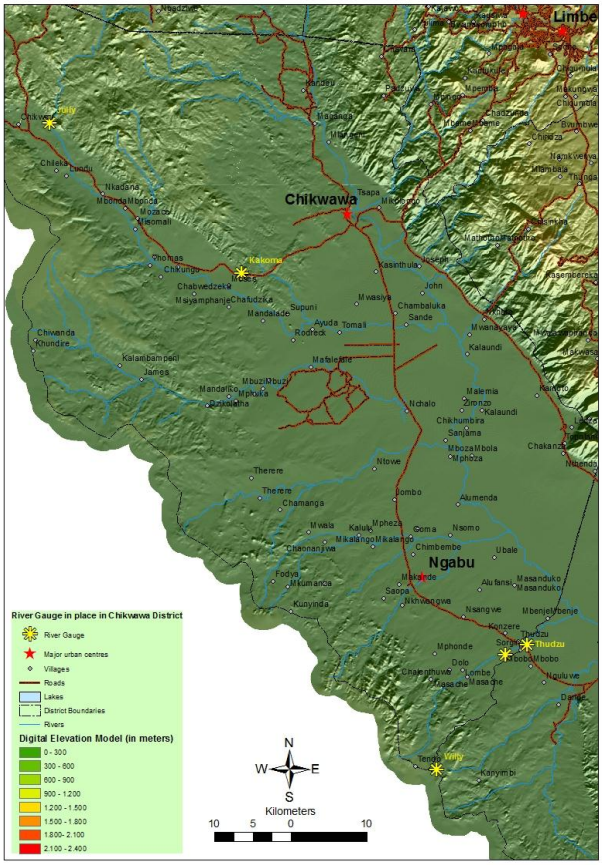
Map:



ID	EWS (named by the location)	x (WGS 84 – UTM 36S)	y (WGS 84 – UTM 36S)
01	Malekesa	8121731	741821
02	Nbenje	8120961	736860
03	Ngabu	8122415	734268
04	Nsilanga	8120295	724285
05	Kanyama	8120315	733397
06	Chitsa	8156910	735497
07	Ngona	8147154	743016
08	Chazuka	8134998	745317
09	Mkango	8138317	745864
10	Nyang'a	8166110	728603
11	Mnembe	8160599	731574
12	Mbenje North	8173943	719537
NGO in charge: Goal Malawi			

Table 10: Location of the EWS in Nsanje District

Chikwawa District
NGO: Christian Aid / EAM
Funds: ECHO
Intervention time frame related to the EWS 2008 - 2011
Activities conducted: rehabilitation of the river gauges and their use as EWS stations, organise and train the local Civil Protection Committee in collaboration with the DODMA officer on DRR, other related DRR activities.
Typology: River Gauge - Used by the communities to monitor the flow and quantity of water. Hydrometric measurements of water surface elevation ("stage") are simplified by colours on a bar in order to give a fast signal to the people in charge of monitoring it. Green colour means there are no risks, yellow means alert and activations of evacuation procedure and the red means consolidate flooding state.
Map:



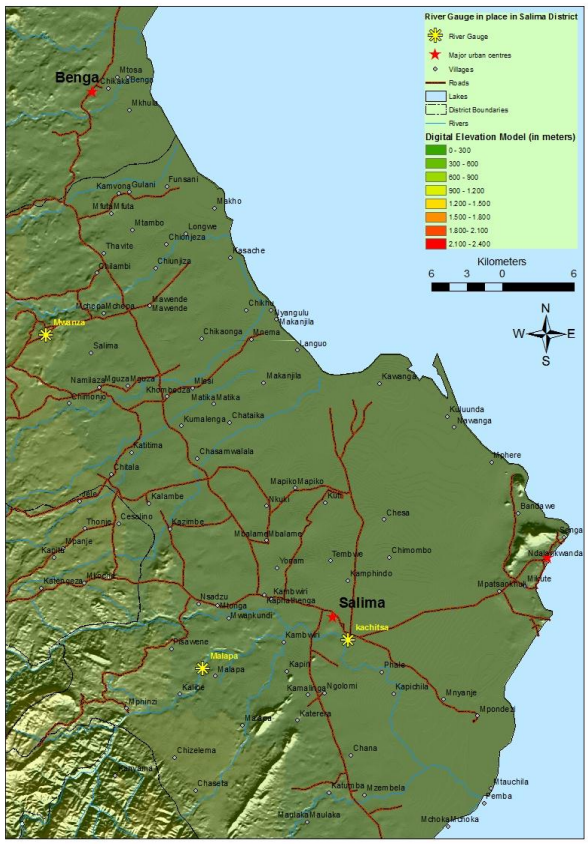
ID	EWS (named by the location)	x (WGS 84 – UTM 36S)	y (WGS 84 – UTM 36S)
01	Buneta	8169437	712599
02	Thudzu	8170322	715244
03	Jully	8238857	652757
04	Kakoma	8219851	677573
05	Rabson	8260950	662316
06	Willy	8154037	703666
NGOs in charge: Christian Aid, Evangelical Association of Malawi (EAM)			

Table 11: Location of the EWS in Chikwawa District

NGO supporting the EWS: COOPERAZIONE INTERNAZIONALE - COOPI

Funds: ECHO
Intervention time frame related to the EWS: 2009 - 2011
Activities conducted: rehabilitation of the river gauges and their use as EWS stations, organise and train the local Civil Protection Committee in collaboration with the DODMA officer on DRR, other related DRR activities.
Typology of the EWS data collection system: River Gauges previously installed by the Water Department used by the communities to monitor the flow and quantity of water. Hydrometric measurements of water surface elevation ("stage") are simplified by colours on a bar in order to give a fast signal to the people in charge of monitoring it. The CPC are instructed for each specific gauge to alert in function of specific level of water as indicated by the Department of Water. The data is collected by the local Civil Protection Committees and transmitted using cell phones.

Map:



ID	EWS (named by the location)	x (WGS 84 – UTM 36S)	y (WGS 84 – UTM 36S)
01	Mwanza	8500420	632365
02	Katchisa	8474533	657838
03	Malapa	8472134	645585
NGO in charge: Cooperazione Internationale (COOPI)			

Table 12 Location of the EWS in Salima District

Information flow:

The EWS assessed supported by the NGOs, involve directly the local Civil Protection Committee (CPC) to collect the data at the measuring stations (river / rain Gauges). The messages are transmitted to the CPC to various villages potentially threatened by a flood. The transmission of the message is done using various methods depending on the distance and the local setting. Among the modalities observed are: use of cellphones, megaphones, radio.
Once the message arrives at the potentially affected village, the CPC personnel in charge spread the alarm using whistles and megaphones to the villagers and transmit the alert to the local district and alert the local rescue and first aid brigades.

However it was clear that the modalities of the horizontal transmission (from a CPC to another CPC) the modalities and the record of events between national and / or district offices and the CPC are less clear. During the assessment, none of the CPC members could give clear indication of how and when they received some sort of vertical transmission neither they could they report clearly the modalities of such warnings.

Use of Maps and GIS for the EWS at District level

The study could not identify any recent map produced by the district government offices specific for EWS in the specific Districts. Only one map of the EWS in the district of Chikwawa was identified. This map shows the EWS activities implemented by one of the NGOs in 2009-2010. This map was produced by a consultant and distributed to various stakeholders but the NGO mentioned that the soft components of the maps (i.e. shapefiles with the coordinates of the information related) were not provided to the NGO itself and therefore the same map could not be further updated or modified.
The other NGOs had several maps produced using a variety of different techniques including participatory approaches. In at least one case the same CPC members assisted to draw maps of the target area of their EWS on the wall near by the gauges station indicating location and cellphones numbers of the various villages to be contacted in case of water related threats. Other kinds of maps include District Hazard maps using participatory GIS techniques integrating satellite imagery (Kienberger 2008[**]) and GPS. These maps were produced in February 2011 with the support of COOPI and ZGIS as part of a development project financed by ECHO to support the NGO partners in 4 countries in Africa. Prior to this exercise the NGOs reported not having used GPS. During this project COOPI and ZGIS teams provided training on using the GPS, participatory techniques and assisted the NGOs to collect DRR information, including locations of some EWS related data using GPS coordinates. During the implementation of this study (June – September 2011) the consultant team of COOPI and ZGIS supported the collection of further geographic coordinates of the various EWS data collection points (river and rain gauges) in the 3 districts.

In one district one NGO had already developed a GIS database including detailed information of several DRR activities. This database is linked to a GIS enabling both NGO and DODMA officer to enter and visualise / analyse data. However such a database was not yet updated to include EWS information apart from the number and location of trained communities. Therefore none of the NGOs and districts had a database specifically designed to collect and archive data related to the EWS. This was probably due to the fact that for some of these NGOs the EWS activities were just recently put in place.

The data collection at the rain / river gauges is done using local Civil Protection Committees appropriately trained by the NGOs in coordination with the district DODMA officers. Each committee keeps accurate records on handbooks provided by the NGOs. However none of these records are currently transferred into electronic format and / or copied for data storage at district level. As a result, it is currently impossible to measure the trend of the river and or rain gauges without going personally to meet the Civil Protection Committees holding the handbooks. The absence of copies and any kind of electronic copies of such records and therefore shortage of a backup system represents a serious risk of data loss. Indeed in one case one NGO reported a loss of data regarding actions implemented in the project. Moreover the lack of data management systems does not allow for a comprehensive analysis of the water level and hazard events at district level in a convenient manner.

Coordination between institutions

In 2010 a new post was established by the government at district level. This officer represents the DODMA office and is in charge of coordinating and supervising DRR programs in the district. Despite the fact that this post is relatively new and often the appointed officer has limited

[**] Kienberger, S. (2008): Toolbox & Manual: Mapping the vulnerability of communities. Available online at http://projects.stefankienberger.at/vulmoz/wp-content/uploads/2008/08/Toolbox_CommunityVulnerabilityMapping_V1.pdf

experience in DRR programs, this initiative seems to be relevant and welcomed by the NGOs and by the local CPCs. In all the districts visited having local EWS in place, the NGOs and the District DODMA officer seem to be closely collaborating to set up jointly the early warning systems, provide the related trainings and other kind of support activities to the local committees. The majority of activities implemented by the NGOs directly involved the DODMA officer who is often part of the training and benefits from the same DRR program. Among other activities done in coordination is the development of District and Local Contingency plans. The DODMA officers generally have a good understanding of the entire program implemented by the NGOs and represent the focus contact point for the District authorities often responsible to liaise between the NGOs and the other district offices.

Efficacy and effectiveness

The NGOs made a real effort to establish EWSs that encompass all the four key elements of an EWS in line with the ISDR definition. This is indicated by the following facts observed during the assessment:

1. Various studies and assessments often done at house-to-house level enable the implementing programme to act upon solid knowledge of the risks (Vulnerability & Hazard).
2. A well-established system of monitoring and analysis of the hazard is put in place. Significant efforts were done by the NGOs to accurately forecast the hazards. The measuring stations were built (or rehabilitated) to forecast appropriately specific hazards taking into account the recommendations given by national and district experts such as the water department;
3. The communication and dissemination of alerts and warnings seems to be effective. In at least four sites the CPCs (generally 10 people selected by and within the local communities) could refer to minor flood events occurring during the last rainy season when they were alerted within good time. In one case, where it was estimated that a flood would hit a community within two hours from the moment the river gauge station showed alarming levels of water, the CPCs at the gauging station effectively communicated down the river to various other CPCs the result being that the threatened villagers were alerted and evacuated in less than one and half hours, well before the flood waters reached their houses.
4. All the CPCs that were visited seem to be fully enabled to respond to the warnings received. Training and organisation provided to the local CPC along with the rehabilitation and sometimes construction of specific assets such as evacuation points are key common activities of the NGOs' programs.

In some districts the NGOs planned and implemented a series of simulation exercises involving sometimes the entire community. During these simulations both the warning dissemination and the responses were tested. Not all the NGOs and CPCs had already conducted such simulations, but all the NGOs indicated that it is in their action plan and will carry on with a comprehensive set of simulations in the following months. Unfortunately at national level there are no clear simulation guidelines, but the DODMA is currently working to provide recommendations to assist DRR program in this direction. CARE France drafted, with the support of COOPI, a simple guideline on simulation exercises aimed to support the DIPECHO partners in four countries within the SADAC region. This document is still in a draft version and should be translated into English in the following months.
No cost effectiveness studies of local EWSs in Malawi have been identified in the literature and during the various interviews with national expert. This is probably attributable to the fact that the EWSs put in place with the support of the NGOs in these 3 districts are all relatively new (2008-2011). More time is needed to evaluate fully the effectiveness of these Early Warning Systems as indicated by the same NGOs and district officers. In fact only a few real flood events have occurred and these at low level scales in the last season and despite the EWS seeming to be fully functional during such events as indicated above, this could be in part associated to the fact that the CPCs were newly formed and trained, highly motivated and monitored or somehow still supported by the existing NGOs programs. Only a sufficient amount of time and real event exercises can prove the efficiency of the systems in place.

In order to promote the sustainability of the Civil Protection Committee members in several target areas the NGOs promoted and facilitated a series of Income Generating Activities (IGA) aimed to self sustain the CPC and cover their costs (i.e. Phone units, maintenance of basic equipment) and create a feeling of self-reliance. Interestingly the CPC interviewed indicated that they engaged in these IGA because they feel motivated by the program and particularly by the training and capacity building program offered.

3.2.2 Conclusion and recommendations related to EWS in Malawi

Both at national and district level there have been considerable efforts to put in place various EWS. Some are efficient and reliable. Some seem to be more information systems, but still important in providing valuable information in a relatively timely fashion. The vertical information flow, from and to, the local communities is sometimes weak, not clearly understood by all the stakeholders in the same way and in some cases non-existent. In other cases the EWSs are limited to the first 3 key elements of the EWS but do not enable the local members to react appropriately.
Within the districts and at a community level, some programmes implemented by some NGOs made strenuous efforts to put in place EWSs that encompasses all the elements of an EWS. Generally it was observed that NGOs showed a real commitment toward this kind of DRR activity by putting together various funds from various projects and donors and sometimes committing their own private funds to ensure continuity of the programme. The EWSs are integrated with the DRR activities and the communities are trained to give an autonomous response in case of flood. Ensuring close collaboration with the District DODMA officers and the involvement and capacity building of the Civil Protection Committees coupled with the promotion of their self reliance is probably the best strategy to ensure sustainability of the EWS long term. Continued training and capacity building is required to fully involve all the elements of the EWS, but this may be the only way to achieve concrete results. Only time will tell if this strategy is cost effective, if the CPC are capable and willing to continue running the EWS and if the IGAs are an effective way to ensure sustainability of the various warning mechanisms put in place. For this a longitudinal study should hopefully appropriately design and conduct to verify the cost effectiveness of these interventions. The fact that the NGOs keep accurate financial records of their programs will be an interesting advantage for the implementation of such a study in the future.

The NGOs and the District DODMA officer prioritised the training and establishment of the EWS and were concerned at first to ensure its functionality. This is reasonable in an early stage of EWS development. However less effort seems to have been allocated to the establishment of a consistent data management system. Data is often inconsistently or poorly collected and stored with a significant number of risks to the loss of this precious information.

Lack of maps and GIS capabilities can hardly be overcome only with training and sophisticated equipment due to the number of districts and turn over in staff. Some NGOs have several time-limited resources. Some NGOs having longer programmes may not have the available funds and the necessary technical capacity to develop independently a GIS database. For those NGOs that have such capacity, the risk is to have a functional system that is unique to a specific district, but not shared with other districts and other NGOs. A simple way to collect and store data should be envisaged, enabling low technical profile personnel to use Geo Information without the need of specific or extensive training. This implies primarily an effort to identify some common and relatively simple indicators chosen by the DODMA. Secondly it should imply the design and implementation of a relatively user-friendly, even if sophisticated, data management system that integrates Geo Information technology and that links national and local EWS information.

Several current opportunities are actually available to further develop EWS in Malawi. There is an increasing awareness by various stakeholders about the need to have proper EWS. The current efforts to finalise the national Policies for DRR are promising and will certainly empower the DODMA office to further develop and monitor appropriate EWS. At the same time, the recent interest of various international donors to offer the support to implement climate change and DRR programs should be seen as a positive opportunity to scale-up a more comprehensive and

harmonised national based and local EWS coordinated by the DODMA. The government may take this opportunity to appropriately angle the available funds in this direction. Similarly the NGOs may play an important role to attract specific funds dedicated exclusively to them to support the national scaling up of the EWS under DODMA coordination.

From a technical point of view the current state of the art Web GIS technology allows you to develop online, user-friendly WEB GIS systems. Moreover the recent progress in telecommunication, particularly mobile technologies, offers the chance to speed up the information flow at all levels. An example is given in the box at the end of this chapter (see box : Interactive Web GIS Database for DRR activities).

Automatic and solar powered gauge stations, meteorological stations and seismographers have been developed, enabling data collection and transmission even during the night-time.

Some recently implemented studies conducted in Malawi including Flood Modelling may offer valuable information on where to locate more efficiently EWS stations. One of these studies was recently conducted for the central region river basin by COOPI and ZGIS with funds from ECHO. Another study is currently undergoing with funds from the World Bank for the Shire River and is estimated to be finalised in 2012.

3.2.2.1 Recommendations related to coordination

The DODMA should be further recognised and empowered by the various ministries and related departments and should play a more leading and active role to define the modality of data collection and data transmission. All the EWSs should be designed and agreed with the DODMA central office. Similarly at a district level any planned EWS should be agreed on and designed in collaboration with the support and the supervision of the DODMA officers. To allow this, a clearer set of recommendations should be formulated by DODMA at central level. However these recommendations should offer flexibility in the specific modalities of a planned EWS related to the local needs and capacities. For this DODMA should remember that the science associated to the EWS is relatively new and benefits greatly from innovative approaches that often, at the outset, may look unconventional.
The NGOs play an important role in recognising the DODMA's role and may contribute to further building the capacity of the district officer. NGOs should continue to support the mandate of DODMA officers and involve them fully during the planning of any future projects.

3.2.2.2 Recommendations related to information flow, GIS and Data management system

Develop a compressive data management system including user-friendly GIS technologies. A Web GIS Atlas may be developed having the following characteristics:

- ➔ Being developed using open source software and envisioned to be modular and flexible
- ➔ All the data from EWSs are stored and accessible online. Incorporate a Central EWS Database including accurate historical trends of the measurements from the various stations (water gauges, rain gauges, etc.) stored along with historical flood event disaster, damages reported. The atlas should also include a detailed map of the station to be maintained / repaired.
- ➔ Integrate Climate Change data and meteorological ATLAS in one single system
- ➔ Provide automatic warning signals from the automated stations to the DODMA officer at District and central level and possibly to the relevant NGOs (using automatic SMS and e-mail)
- ➔ Incorporate scenario based and flood modelling developed by various stakeholders
- ➔ Incorporate automatic data collection / transmission and visualization from meteorological stations and seismographers
- ➔ Integrate relevant layers such as population density, topographic and morphological information.
- ➔ Enable historic analysis of previous record, warning, hazards and vulnerability factors.
- ➔ User-friendly modalities to generate / customize / print maps.

- ➔ Possibility to upload data easily AND link with the Water and Climate Change and Met. Dept.
- ➔ Monitor the current status of the EWS and Identify specific gaps / needs
- ➔ Enable off-line visualisation of specific sets of data
- ➔ Enable rapid mapping using Google Earth technology
- ➔ Enable the District Dodma officer to upload and download in real time geo-referenced information and pictures related to rapid assessment.
- ➔ All the available data mentioned above should be made accessible previous authorising from the relevant stakeholders and possibly in line within the framework of a Spatial Data Infrastructure (please refer to chapter 4)

The DODMA should lead, possibly with the support of a technical consultant team, the process to develop such a system and the NGOs should be directly involved to choose harmonised indicators of such a system since they are well placed to contribute to feed the system in the future.

At a district level the DODMA officer should also be the focus data management officer. He / she should be assisted by the NGO. For this reason the central DODMA office should play a key role to instruct the district DODMA officers and encourage the collaboration and synergism between them and the NGOs as a key strategy to map out all the DRR activities (including the EWS) and carrying on the data collection procedures.

DODMA officers at district level should ensure the role as information dissemination officers and ensure that the vertical warnings should be sent to him / her and copied to the district commissioner.

Research institutes in Malawi should be directly involved to provide the academic support to carry on studies and operational research related to the EWS with particular regards to a) the long term sustainability and cost efficiency and b) the development impact of the new data management system put in place.

Box 4 An example of an Interactive Web GIs Database for DRR activities

Disaster Risk Reduction is a complex and multidisciplinary matter. Coordination between actors is one of the key challenges and sharing information is the first step to build preparedness and organise response. Particularly, geographic information, maps and ground truth data is necessary information that needs to be shared by actors operating in the same intervention area to guarantee a prompt response. The purpose of the WebGIS DRR database is to promote dialogue among regional DIPECHO partners carrying out disaster preparedness activities and to support government institutions with useful information about activities promoted in each country. The database is accessible through the following web page: www.gi4drrdb.coopi.org. This WebGIS DRR database is developed by COOPI and Z_GIS with funds from the European Commission Humanitarian Office.

The WebGIS database runs on a LINUX Server. The database is developed in MySql, and the web application is run on an APACHE webserver, extracting data from MySql database using PHP programming language. The structure of MySql database and its tables depends on the chosen data sets. The data set is given by DRR activities' themes carried out by each NGO, such as: early warning system, capacity building, infrastructures, wash-sanitation and food security. Each activity's theme is described by a set of indicators purposely in 2011 chosen for this database, identified by NGOs partners having received funds from DIPECHO programme and by consulting staff from the national disaster preparedness offices, such as DODMA in Malawi. Each indicator represents a specific field in the MySql database. Tables from MySql database have been designed by the project manager and the IT technician. At the same time, a web page has been created including a Googlemaps platform to visualise geo-referenced data. Refining of the page, including pop up windows and creation of reserved area for data entry and editing has been done. Finally information has been collected from the project managers of each NGO, loaded into the MySql database and finally visualised into the webpage. After completing the 'server' component, the 'client' side has been developed. The Android application Open Data Kit (ODK) has been used to collect data from tablets and transmitted to the webpage. Forms have been developed using the ODK-built web application and then linked to the MySql tables. Therefore, data can be entered directly from the website or by using ODK.

The web site is made of two main components: a map, (Googlemaps) and a table, with indicators referring to the types of activity. Three drop down menus (Country, NGO and activity) allow you to filter data on the map, in the table and to define the map scale and zoom range. It is possible to click either on the table or on a specific icon on the map to visualise further information related to that point in a pop-up window.

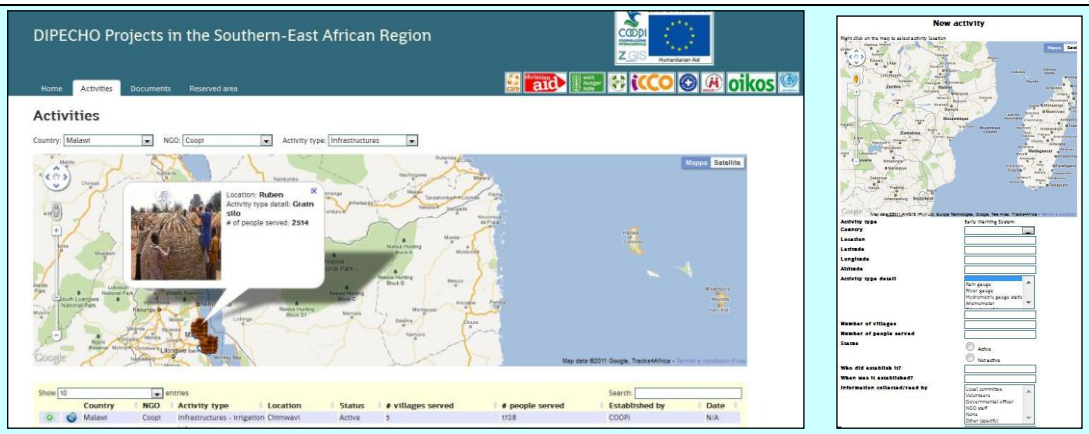


Figure a) data visualisation of the online Web Gis DRR database - Figure b) data entry page for individual institutions

The database also includes a section for documents, where NGOs have the possibility to upload and share files (.xls, .ppt, .jpg etc…) and a reserved area, where only authorised NGOs (provided with a password) can edit or enter information.

This database is user-friendly and intuitive. It does not require any specific IT skills and therefore it is accessible to any type of user. Information is available both to field staff and supervisors from the NGO and or Government Officer. 'Google maps' is a well known and intuitive platform. Also, drop down menu and multiple choice questions simplify the data entry process. The data can be loaded in three different was: 1) by filling in offline in an excel file provided by COOPI that is sent to the Server Administrator and loaded in the database; 2) directly online data entry using a password and ID username provided by the administrator, an institution can create its own map and enter all the indicators geo-referencing the exact locations either by entering GPS collected coordinates either locating directly on the 'Google map' the specific activity site; and 3) using smartphones or tablets integrating an ODK questionnaire. In fact the ODK application is another important advantage of this tool as it is a fast method to enter information into the database, overcoming the problem to access and modify data directly on the webpage if Internet connectivity is limited. Geo referenced data is stored in the tablet and sent to the web-server when a network is available.

This database provides also significant information about Early Warning Systems (EWS) set in the countries, such as: number of villages and population served, type of EWS, data about people/organised groups collecting information (committee, government institutions, etc…) and the modality to transmit it (radio, cellphones, etc.) from upland to lowland areas.

Currently, this database allows the information of local/national and regional actors about activities implemented by DIPECHO partners. During the regional workshop organised by CARE and FAO on the 25th-28th October 2011 in Johannesburg, COOPI presented this tool and invited all the NGOs operating DRR program in the countries of Malawi, Mozambique, Madagascar and Comoros Islands to freely subscribe and share their activities' data if relevant to the database structure. More data will be added in the near future and due to the high flexibility of the system, many other applications for this database can be identified in the humanitarian sector.

3.3 Achievements and challenges concerning climate change adaptation in Malawi

As indicated in the introduction of this report (chapter 1.4) this chapter briefly summarises the observed achievements and challenges concerning DRR and CCA in Malawi.

In the following section the **achievements** at both national and district levels are presented. During the entire in-country assessment it became obvious that a) relevant stakeholders involved in DRR and CCA activities at a national level are already working closely together b) the Department of Disaster Management Affairs (DoDMA) already plays a key role in post-disaster recovery c) that the role of DoDMA for DRR and CCA measures will be further extended and strengthened as soon as the new 'National Disaster Risk Management Policy' is officially implemented by the Government of Malawi (GoM). This Policy is currently in draft version only. Moreover, although, as discussed in chapter 3.1, GI for DRR and CCA capacities vary between and within institutions and are often based on single individual capacities and efforts, it is also evident that specific human capacities already exist in some of the key institutions being involved in DRR and CCA in Malawi. The launch of the 'Malawi Geographic Information Council' (MAGIC) in 2004, was a key step towards the establishment of a National Spatial Data Infrastructure (NSDI) as proposed by the consultants (refer to the box above and see chapter 4). The assessment at district and local level (i.e. in the communities) has shown that the relevant stakeholders at sub-national level have detailed knowledge of (i) the state of the environment and of influencing or threatening factors, (ii) local infrastructure and their state of maintenance (iii) all relevant stakeholders being involved in DRR and CCA activities in their district or adjacent communities.

However, the consultancy also unveiled several **challenges** at both a national and a sub-national level that need to be addressed to strengthen CCA and DRR capacities in the country. In line with the above reported gaps, limitations and needs concerning GI for CCA and DRR (see chapter 3.1.3), these challenges comprise existent (i) data management (e.g. data storage, availability of backup-systems, meta-data, standards, etc.) solutions and (ii) data sharing procedures (e.g. lacking use of web services and missing National Spatial Data Infrastructure (NSDI)) not only within government institutions, but also between government and international organisations, academia, civil society organisations and donors. Any exchange of data between stakeholders at national and sub-national levels is non-existent at this time, resulting in huge data gaps at a sub-national level. Moreover, the technical infrastructure at the national universities and colleges is not sufficient at this time to foster capacity building for, and to provide specialised training to, national key governmental institutions which are active in the field of DRR and CCA. As the assessment has shown the same applies for the government institutions at national level where, with the exception of singular departments (see chapter 3.1.2.1) the availability and usage of dedicated, licensed GIS, GPS, remote sensing software and related equipment is very limited or out of date.
Some other important challenges that may affect the optimal capacity to implement Geo Information activities related to Climate Change and DRR are the following:

- the current fuel crisis (fuel shortages and price increases) associated to shortfall of foreign currency in the country affecting mobility and therefore the capacity to collect ground data
- power shortage - current and frequent power cuts associated to the reduced production of electricity and thus inability to meet demand. Consequences of power cuts and the lack of energy back-up systems – resulting in the inability to operate computers or other electronic devices, sometimes during several working hours.
- disproportionate cost of Internet coupled with very low connectivity. Despite the country now having two fibre optical systems, the availability of high-speed internet connection remains low and only a few districts have access to it. In districts where it is available, the costs are often prohibitive without the appropriate budget approval from central government and funds from external donors
- lack of financial and economic resources of the various government offices
- relatively higher cost of new technology in Malawi compared to other countries.
- complex network of relationships between ministries, agencies and NGOs; limited knowledge about a) who is in charge of what data and b) data, documentations and hardware available in the other stakeholder's offices.
- at district level there are still some uncertainties about 'who does what'.

4 GENERAL CONCLUSIONS AND RECOMMENDATIONS

'Humanity is at a point in its history where it has, for the first time, the power to fundamentally alter, within one or two generations, the conditions upon which societies have evolved over millennia. It is the speed of environmental change, including climate change that will be increasingly at the heart of our collective concern and response. In bringing forward a response that enhances global security and cooperation on climate challenge adaptation. The world can perhaps also better manage risks from numerous other challenges and in doing so, diminish tensions between nations and lay the foundations for the possibility of a more sustainable and equitable peace'.

With this appeal the UN Under-Secretary-General and UNEP Executive Director Achim Steiner ended his speech at the UN Security Council Debate on the impact of climate change on maintaining international peace and security on 20 July 2011.

Climate change is a global, multi-sectorial and interdisciplinary issue. As a consequence, adaptation, as well as mitigation, requires intensive and continuous cooperation – on local, regional, national and global levels. Observing change – in ecosystems and livelihoods alike – can only be achieved by monitoring key indicators and communicating anomalies and trends to those who can take action. The spatial visualisation of changes is an important element of this communication process. The pre-requisite for any nation to effectively face the challenge of global warming and climate change is therefore an efficient management of geospatial data covering its territory.

Based on the findings identified by the recently conducted consultancy 'to assess the current hazard mapping capacity and effectiveness of scenario based tools for long term planning mechanism' conducted by COOPI and its partner Z_GIS, Malawi has established the framework for a plan of action identified within the activities in the 2011 AWPs for the Africa Adaptation Programme (AAP) and Disaster Risk Reduction (DRR) as well as the NAPA Programme. Malawi also has expert capacity to carry out required action; this capacity has to be strengthened.

The **key observations** to be addressed for effective carrying out of long-term planning in Malawi are:

- *Spatial data infrastructure*
  Presently spatial data are distributed, hardly accessible, and kept in different non-compatible formats hindering sharing of data/information.
- *Hazard and vulnerability assessment*
  The key drivers of climate change and the major natural hazards concerning Malawi are poorly understood and hotspots not mapped in a way that local actors can plan mitigation, adaptation or risk reduction measures.
- *Knowledge and skills*
  The existing skills in handling Geo Information are scattered over a few institutions and only 2-3 universities/colleges are building capacity for geospatial analysis. Lacking awareness about spatial analysis and assessment (monitoring and observational evidence) on policy level is causing limited knowledge about the effective use of information for decision making.

The recommendations are divided in two parts: a **general approach** and **detailed short-term interventions**.[††]

[††] It was not part of the objectives of this report to investigate and or report in detail the existing funds availability or commitments form various stakeholder. However, as a general observation, it was appreciated a significant effort from some agencies such as UNDP and World Bank to funds and address the needs and gaps related to the GI sector for Climate change. We therefore hope that this section may be of some use to direct further the use of potential resources.

4.1 General recommendations

In this part, recommendations are formulated based on ideal conditions to be achieved by successfully completing the suggested activities[‡‡].
The recommendations are derived from

A) the discussion had with the various stakeholders during the interview,
B) the discussion and elaborations made during the workshop organized by the consultant (COOPI and ZGIS) on the 4th October in Lilongwe,
C) the experience of the consultant team based on other countries example

1. The Malawi Geoinformation Council (MAGIC) and the National Spatial Data Infrastructure are operational.
Participants of the final workshop explained that an initiative to establish an SDI in Malawi had already started some time ago, but due to a series of reasons, particularly the lack of resources, coordinating effort and support, it was abandoned in the past years. SDI is an essential framework to ensure data sharing and management at country level to the benefit of all development sectors. The former Malawi Geoinformation Council (MAGIC) and its implementing body, the National Spatial Data Infrastructure (NSDI) centre, should be reactivated and re-enforced according to the legal provision of the National Land Policy of 2002.

MAGIC should incorporates the senior officers from the various government institutions / departments. The role of MAGIC would be to pull together the interest and commitment of the various stakeholders towards the SDI and mandate the NSDI to put into operation the related activities. The NSD centre should have its operation core within the Survey Department since is the one having the official mandate to hold the geo data in Malawi.
External support to this centre could be provided by an in

Activities:

- update the statutes of MAGIC and NSDI
- compile the membership
- develop an operational plan for MAGIC and the NSDI (for 2012)
- organise and hold regular meetings (in 2012)

2. SDI principles and guidelines are formulated for Malawi with the support of SDIAfrica.
Recognising that the Government of Malawi has undertaken several initiatives at a national (National Land Policy 2002) and international level (e.g. partner country to the UN GGIM 2011[§§]), the establishment of a Malawi Spatial Data Infrastructure should be based on the existing building blocks. The experience from neighbouring countries in the region and Africa-wide initiatives, such as SDIAfrica coordinated by UNECA[***], provides support to the process. The main outcome should be a policy document outlining SDI principles for Malawi (e.g. institutional set-up, mandates, data sharing principles, data formats etc). The steering group of the Malawi SDI needs to convene regularly to resolve problems, create consensus, and advise on policy requirements. Members of the group should also attend respective African meetings, such as CODIST, AfricaGIS, AARSE, etc).

Activities:

- compile existing legal documents and update inventory of implementation papers & studies
- draft principles on data sharing by exploring the Implementation Guide provided by SDIAfrica
- organise workshops with government experts and experts from SDIAfrica
- adopt policy document on SDI principles in Malawi
- attend meetings on regional and international level (CODIST, AfricaGIS, AARSE, etc)

[§§] See http://ggim.un.org/
[***] http://geoinfo.uneca.org/sdiafrica/default1.htm

3. Advocacy on SDI principles carried out.

The concept of Spatial Data Infrastructure is geared to building together, as data users and producers, a common data resource, a collective data asset, including management tools and rules. An operational SDI facilitated by a clearinghouse mechanism enables potential users at country level to find out what data exists, where and how to access it and under what conditions it can be used with the objective to derive from the analysis of such data meaningful information for decision making. Seen from a country perspective, the various data sets do not need to be centralised in one location. They will be kept accessible over distributed computer networks in as many locations as there are data contributors. The possibilities to query the corresponding meta-database and to perform analytical operations and transactions on the actual data over the network are part of the facilities offered by the SDI. This is according to the agreed rules and procedures and of course entails a form of organisation. The target audience of an SDI is so large and the potential uses so diverse that consensus building through a participatory approach is essential for its design, involving both Government agencies and institutions from civil society. This approach leads to a consensus-based definition of goals, objectives and outputs. To this end, continuous outreach and advocacy is required to keep decision makers informed and the technical level on the right track (e.g. by external and independent evaluation).

Activities:

- create information products for awareness building on SDI (folders, brochures, slide shows, posters)
- hold awareness events (seminars, workshops) for government institutions
- produce a series of newspaper articles, radio features and TV interviews on SDI
- organise a regional conference jointly with SDIAfrica in Lilongwe
- ascertain compliance with SDI standards and principles for government and donor projects (e.g. external evaluation)

4. An inventory of existing spatial data is established compliant to SDI standards.

The putting into operation of the SDI requires some technical measures to address the following issues: (a) what data/information is available (meta-database) (b) in what format (c) how can the data/information be accessed. This is the technical infrastructure to make data/information, (primarily baseline data) flow between providers and users.

Activities:

- design web-based meta-data form and database
- inform all relevant departments about use of form and specifications required
- implement data transfer policy (e.g. web-server)
- upgrade the technical infrastructure to provide geospatial baseline data at Land Survey Department and DODMA (e.g. DEM, roads, settlements, etc.)
- design and establish a national web-GIS platform as a service delivery point (a suggested location could be the DRR Resource Centre, inaugurated in 2011 in Lilongwe city centre since already used as an information centre)

5. A Climate Change Atlas on key drivers in Malawi is compiled and regularly updated.

The multi-sectorial and interdisciplinary nature of climate change assessment is seen as an ideal starting point for a national SDI. Recognising the involvement of many diverse institutions as data/information providers, the SDI steering group can facilitate the confluence of data required to establish evidence about key drivers of climate change in a spatial context. In this sense, the atlas will be a 'living document' permanently updated by newly captured data and accessible via a web-portal. During the interviews the World Bank mentioned the current intention to contract a consultant team to develop in the following months (2012) an Atlas focusing primarily on climate changes and meteorological aspects. This initiative is indeed an important step forward. This report offer a series of suggestion and element the Atlas should incorporate in order to take the opportunity to develop a 'compressive atlas that encompass a variety of useful thematic maps and dynamic modalities of use. Some of these recommendations are reported in the following section as part of the second short term intervention.

Activities:

- define the key change drivers for Malawi (main chapters of Atlas)
- develop a concept for the integration of relevant data layers (hazards, vulnerabilities) on national scale
- reach consensus on scenarios to be used (climate change, development agendas)
- implement the atlas on the national web-GIS platform
- provide hardcopy brochures with explanatory notes for decision makers and schools
- ascertain regular updates of the atlas

Refer to the chapter 3 and short-term recommendation below.

6. Vulnerability assessments in support of DRR and CCA are carried out for 2 most affected districts (Nsanje and Salima).

Moving beyond hazard mapping, vulnerability assessment provides the challenge to compile data of very different nature (e.g. land use and demographic information) to carry out the analysis on a sub-national level. As adaptation to climate change or disaster risk reduction measures can only be planned and implemented on a local level, accurate and precise information on the factors of vulnerability is crucial. With an operational SDI in place, the challenge is moved from accessibility to resolution – what data/information is available at the required scale to serve the needs of actors at district or community level.

Activities:

- adapt vulnerability framework for conditions in Malawi integrating DRR, CCA and livelihood approaches
- develop critical set of indicators and compile required data (incl. remote sensing, socio-economic, population, geospatial baseline data)
- model vulnerability domains by integrating expert knowledge
- visualise results and indicators as part of the national web-based atlas

7. Academic institutions establish a GIS / RS Centre and build local capacity to manage and integrate geoinformation for development in Malawi.

The assessment proved that in Malawi there are already local capacities and institutions, such as the Bunda College (becoming Lilongwe University of Science and Technology), Chancellor College, Mzuzu University and the Polytechnic that incorporate in their training programs the use of GIS and Remote Sensing (RS). Despite the needs and gaps identified in terms of resources; it is evident that the existing efforts and courses could already offer an optimal platform to enhance local capacity on using GIS and remote sensing for climate change and DRR in Malawi for present and future Malawian students. The development of research capacity and the link with regional and other international initiatives may stimulate and strengthen the necessary technical support which these training and research centres needs to support an SDI in Malawi.

It is therefore recommended to reinforce these institutions' capacity with a series of actions conducted by a solid and experienced academic institution having experience in similar actions in African countries.
We therefore recommend to open a GIS / Remote Sensing Centre following the model of other GIS centre currently operating in developed countries (ie Z_GIS) .
The intervention should address the need to equip the institution with adequate hardware and software as well as other educational equipment, building staff capacity and contribute to link the GIS / RS Centre to other initiatives outside of Malawi.
At the same time the GIS / RS Centre can train local experts on local scenarios by using GIS and RS.

The GIS / RS Centre should be a semi-independent centre with the following characteristics:

- Develop a lecturer support team and an exchange /share of experts between Universities Colleges able to back up all the Universities and Colleges that experience lack of qualified lecturers, technical material and support to develop / upgrade the curricula.
- It should be a centre established within the Bunda College (becoming Lilongwe University of Science and Technology), but representing and serving in equal manner the other Universities interested to be part of this Centre. The main reasons to have it at Bunda College is associated to its geographic centrality, the space of the facilities and the closeness to the Survey Department.
- Benefit from the technical support of the various institutions and departments; particularly from the Survey Department, but having its own staff, premises and agenda.
- Pool together the key expert of GIS and RS in Malawi on regular basis for discussion and way forward
- It should be autonomous and able to develop its own strategy and fund raising mechanisms
- The centre should have develop and uphold a strong network of partnership with strategic NGOs and other Geo Information Centres in other countries that actively contribute to the development and implementation of the projects. Some of these projects to be lead by the NSDI centre, some lead by its own partner (other centres and or NGOs)
- Directly plan and implement the activities related to the establishment of the SDI and provide concrete support the Survey Department to implement activities mandated by MAGIC
- Be the custodian of one of the back up system of all the data kept by the Survey Department.
- Have an independent clear funding strategy. The GIS / RS centre incorporates the support of key NGOs and other private and public institutions from various countries to attract specific projects funds from international donors.
- Provide an open accessible service delivery point in the capital (i.e. the DRR Resource Centre)
- Report to The Malawi Geoinformation Council (MAGIC)

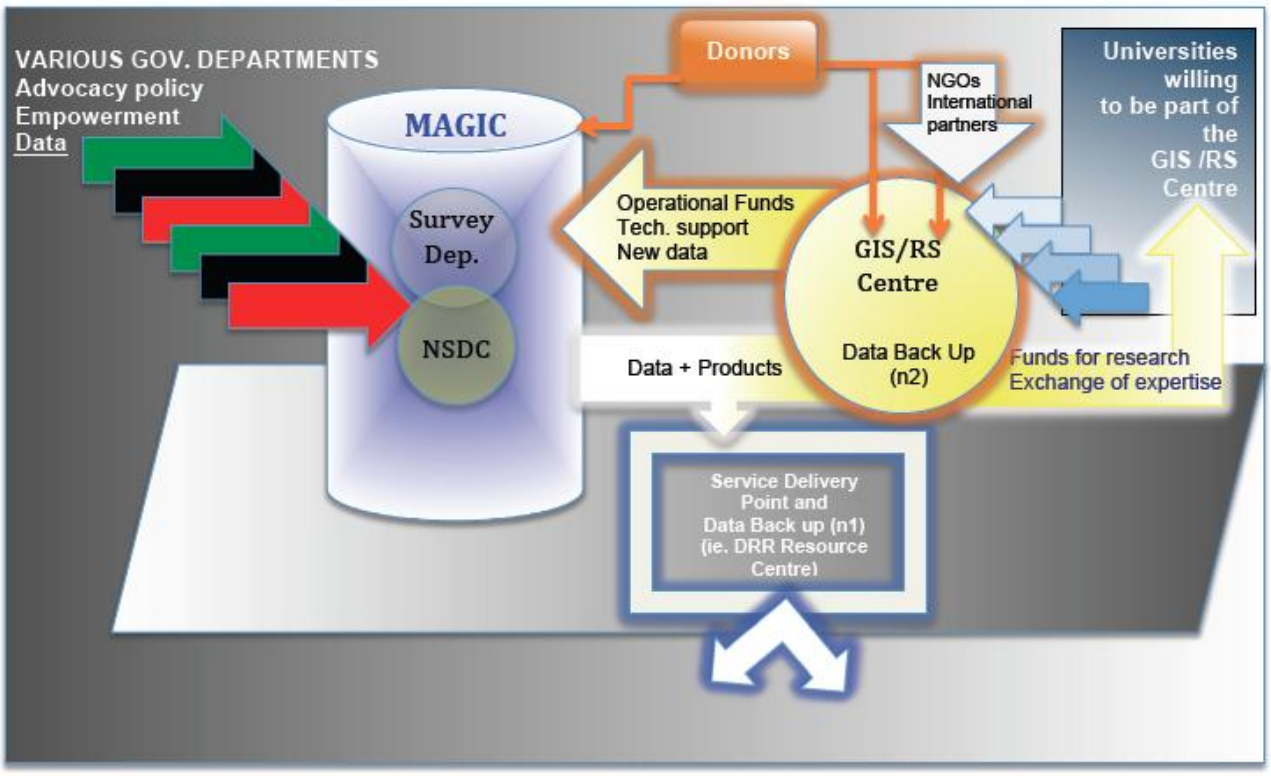


Figure 9: interaction between MAGIC and GIS /RS Centre

Activities:

- Facilitate the opening of the GIS / RS Centre
- The GIS / RS Centre is equipped with and maintains facilities for the delivery of quality training and research
- Develop a curriculum and associated courses to serve the different needs in geoinformation within Bunda College and other Universities part of the Centre
- Ascertain human resources having the capacity to respond to the educational and research tasks
- Establish collaborations and links within a national, regional and international context in regard to building capacity for teaching and implementation of research projects
- Carry out research and outreach activities to support the improvement of a national spatial data infrastructure and climate change issues in Malawi

8. Capacity building measures are developed and provided at institutional level.
Innovation always requires the support and the infusion of new concepts and methodologies from universities or colleges. These institutions need to be prepared to provide skills training and events for awareness creation for experts outside of their walls. SDI has to be stimulated (champion award) and to be communicated to the policy level (science-policy-dialogue).

Activities:

- design an SDI curriculum for experts
- topic 1: data standards and meta databases
- topic 2: GIS concepts
- topic 3: data integration
- award for an SDI champion on a yearly basis
- stimulate science-policy dialogue

4.2 Detailed short-term interventions

The proposed interventions have been formulated taking into account

1. the feedback provided by the stakeholders met during the various interviews conducted during the consultancy study
2. the suggestions provided during the workshop organised by COOPI and Z_GIS on the 4th October 11 to present the preliminary result of the study
3. the existing current action plan and budget availability of UNDP

The intervention proposed, ultimately aims to address the holistic approach to (a) promote a sustainable and effective use of geoinformation at country level (b) reinforce the in-country capacity building process for using GIS and Remote Sensing. This includes a road map to promote the establishment of a Spatial Data Infrastructure (SDI) in Malawi as an essential assumption to allow constructive, enhanced and above all increased use of geospatial data.

However, considering that the establishment of an SDI represents indeed a long-term process and recognising the needs by government and its partners to generate within a short period of time specific maps and geoinformation outputs serving climate change programmes as well as disaster risk reduction measures, we included a series of short-term interventions. We believe that those meet some of the actions identified within the planned activities of 2011 AWPs for the Africa Adaptation Programme – AAP and Disaster Risk Reduction – DRR.

In this section we present the intervention we believe could be **implemented in the following 12 months**. Realistically, the consultant team recognises that the long-term programme proposed in the following section may represent some constraints on funding and require more time to be implemented. The choice of these specific short-term interventions are therefore dictated by the resources available such as indicated by the AAP DRR program and the need to initiate key GIS activities that practically contribute to the achievement of AAP priorities. At the same time however

we carefully choose activities that represent key milestones to achieve the overall objective for the long term plan, namely:

'An effective SDI and the related capacity building framework is existing in Malawi supporting the planning, implementation and evaluation of national DRR and CCA programmes'

We strongly believe that the Climate Change Committee and all its members should be aware of the importance of the SDI as a necessary framework enabling Malawi to properly manage its geoinformation resources and ease data availability for decision makers in the context of the Climate Change Adaptation program and DRR. This is the only way to ascertain the sustainability of any outcomes developed. Therefore, even if the short-term interventions are conceptualised to deliver concrete and tangible outputs, the underlining activities are formulated in order to contribute to a more global achievement of the SDI and local capacity building in Malawi.

Two short-term interventions are proposed for the following twelve months. They are presented according their priorities.

1. The first intervention (first priority) addresses the capacity building on the short term recommended (training modalities and subjects) and the equipment and infrastructure to be purchased / provided.
2. The second intervention and priority addresses the need to generate hazard and vulnerability maps and incorporate geoinformation in a dynamic Web-GIS Atlas using refined and solid methodology.

A third potential medium-term intervention is addressing the need to build the capacity to use GIS at the using academic institutions. This third intervention should be considered as a medium term plan and is already described above (page 52-54) under 'Academic institutions establish a GIS / RS Centre and build local capacity to manage and integrate geoinformation for development in Malawi', and therefore not repeated in this following section.

These 3 interventions may be implemented separately. However, considering the interlinks of some activities, we believe that the optimal scenario would be to implement these components jointly as part of a single action coordinated by the same actor identified by UNDP.

4.2.1 First short-term intervention

In this section we present some practical short-term intervention that could be implemented in the following months. This first short term intervention is priority to the second one. The activities are part of the general recommendations for the long term plan mentioned above but have been chosen in function of the requirement stated in the term of reference of this consultancy and with the intention to adhere to the availability of resources indicated by the contracting agency.

Key objective:
Equipping the government of Malawi with adequate 'training' and 'infrastructure' for GIS and Remote Sensing.

Training

The consultant team does not believe that short-term trainings to non-dedicated GIS staff is cost effective of sustainable. Proper skills improvement on mapping and general GIS should be seen as a national academic goal to be pursued using the appropriate platform of training institutes on the long run. For this reason in the long term strategy it was stressed the importance to involve and strengthen Universities (possibly by establishing a GIS /RS Centre). Often trainings to non-dedicated staff, that are already fully committed to their day to day activities, results on a restricted understanding of the GIS principles and capacity to interact limitedly with the GIS software proposed. Moreover, often government staffs are prone to turnover and change of duty and offices.

It is important to remind that

A) long term training and capacity building that can be acquired only during long years of specialist courses,

B) the GIS and RS sciences are extremely dynamic and need to constant adaptation and attention to the new application offered by the market and

C) it requires constant / almost full time practice by the GIS officer.

It is noteworthy that a proper use of GIS and RS for Climate Change and DRR require particular skills because of the complexity of the topics and the need to articulate special geo data sets with a stronger scientific background.

It is for this reason that we recommend to 'hire' a dedicated GIS officer with the appropriate academic background to serve the CCA committee. This officer could therefore play a role to

a) develop, generate and manage the GIS / RS dataset

b) provide on-going training to the CCA committee (including DODMA)

(a term of reference for such position is proposed in the annex section)

We also believe that it would be more appropriate to develop a Web GIS database that enable simple interaction and online maps making as the one recommended in the chapter 3 and in the second short tem intervention (see below, short term recommendation 2). The appropriate development and use of a Web GIS Atlas may not require specialized training and skills and could respond to the majority of day-to-day needs of the non specialized users.

Nevertheless, in line with the original request of the contracting agency, we propose a series of short training modules to be provided to some key actors within the government. The short-term trainings modules should be provided by

1. First option - either the GIS officer in charge of CCA and DRR (new professional figure recommended above); this option allow to use this new figure more flexibly for training mapping, GIS data set manager / librarian
2. or Second option - by an external consultant (generally more expensive).

In the future however the GIS /RS Centre that we propose to be established within the University could later play a key role to foster the capacity building of the single departments (refer to result 7 and 8 of the long term general recommendation above).

Location of the training: Lilongwe in a Education Centre equipped with 10 PC (one per person), 3Gb RAM, Window 7.
Number of trainees per session: ≤ 10 (at least two for each Department)
Frequency of training session: one full day per week

Please refer to the training modules proposed and the Excel table in the annex section for the budget.

Equipment (Infrastructure)

This intervention addresses the activities related to recommendation 4 (4.4), and 7 (7.1):

- 4.4 upgrade the technical infrastructure to provide geospatial baseline data at Land Survey Department and DODMA (e.g. DEM, roads, settlements, etc.)
- 7.1 The GIS / RS Centre (within Bunda College) is equipped with and maintains teaching, training and working facilities for the delivery of quality training and research

This intervention aims primarily to support the following 5 distinctive, but interlinked offices / department.

In Table 13 below we indicate the beneficiary office with the rationale of their selection.

Beneficiary o f the action	Typology of intervention	Rationale
Land Survey Department, Central office in Lilongwe	IT and GIS equipment Remote sensing Data Network system Internet and Intranet Database Maintenance services	Focus point of all the GI data. Protection of data and digitalisation of archives. Communication with partner Source free data Having the mandate of Geoinformation Management in Malawi and the most appropriate institution to promote SDI.
DODMA at central level	IT and GIS equipment Network system Internet and Intranet Database Maintenance services	Primary users of GIS and Remote sensing for DRR Data protection Communication with key partners
DODMA offices in 4 districts: Nsanje, Chikwawa, Salima and Karonga	IT and GIS equipment Network system Internet and Intranet	Primary users and data collector at district level and therefore need to empower the capacity to collect, sort, send and receive data in the right format. Vulnerable districts prone to various hazards.
DRR Resource Centre, at the Natural Sanctuary in Lilongwe All material belonging to the Survey Department	IT and GIS equipment Network system Internet and Intranet (connection to the Survey department and DODMA)	Serve as back-up data service point of both for the purpose of MAGIC (data hold by the Survey Department) and the GIS / RS Centre Potential delivery point for GIS and RS services for various actors wishing to access to maps, data, material and technical support.
GIS / RS Centre (within Bunda College)	IT and GIS equipment and software with educational	Promote functional laboratory of GIS and Remote Sensing / Serve all academic institutions / Serve a second back up system

Table 13: Beneficiaries of short-term intervention

The equipment and software licenses to be purchased have been identified taking into account the following aspects:

- gap assessment done (physical check and collection of the inventory list). This included
    a. the analysis of various factors contributing to the proper long-term management and maintenance of the recourses to be provided;
    b. the needs of specific supplies to a) promote the capacity to generate appropriate mapping material b) contribute toward the proposed next short-term intervention c) to achieve the overall programme (long term programme)
- list of equipment identified by the beneficiaries as required for their routine work;
- available amount indicated by UNDP for the current program. This is a very important aspects that obliged to restrict primarily the Survey Department and DODMA as first offices beneficiaries;

In relation to the latest point it is important to remember that the Survey department has the legal mandate to manage / store / process / provide the primary geographic data and is the first one to be involved for a potential SDI program. Therefore it is natural to prioritize this office. Moreover the Survey department is central both geographically (based in Lilongwe). This make the Survey department the appropriate office to be capacitated to offer valuable services to other government department (ie. forestry office) in case of specific need of tools more likely.
The DODMA office represents as well the first line of beneficiaries of any project aiming to increase GIS potential in the context of Disaster Risk Reduction. Both offices are part of the Climate Change Committee and therefore interlink with themselves and other government offices, but represent the first intervention in case of disaster. However in case of increased availability of budget the same items with particularly emphasis to the internet services are recommended to cover the needs of the other departments. In such case the minimum amount of items / services should be the same proposed for the DODMA office under the long term purchase section (with

exception of the items already available in the specific department). In this case a short update of the assessment should be done no more than 2 months before purchasing and the complete and fully documented inventory of the assets (including all the element mentioned in section 3.1.2.1) should be first provided in soft and hard copy signed by at least 2 officers and the director of such department.
In the table Procurement (refer to annex section) we have accounted for the various supplies and equipment required with an indicative budget. Please note that this budget is based on price units that have been quantified using web based searches for some of the items and quotations for other items. The prices are therefore subject to a certain variance due to exchange rate fluctuation. Moreover, these prices are to be considered duty-exempted based on the assumption that the funds are coming from international donors for use by government institutions.

Cost of the Intervention 1

The estimated cost of this short-term intervention is 200.000 USD
Please note that we have prepared two tables:

1. The first one includes the overall ideal investment based on the full needs identified.
2. The second table shows the priority investment to a maximum of 200.000 USD in line with the amount available as indicated by UNDP.

Additional comments

Internet and IT maintenance services for the DODMA, Department of Survey and the DRR Resource Centre:
A good internet connection and IT maintenance is absolutely crucial for appropriately using GIS and remote sensing technologies**.** The gap analysis proved that lacking internet and IT networking and maintenance services are some of, if not most, of the limiting factors. A good connectivity is essential to download free data available on internet such as the Landsat /NASA archive that could be used to generate land use and land change information in Malawi as recently demonstrated by Z_GIS in the context of the central river basin study (see presentation in related report).

The internet and intranet system in both Departments should have the following characteristics:

1. One fast broad band connection (min 2 MB) for 2-3 dedicated computers used to download / upload large amounts of data.
2. One low band (less expensive), but possibly dedicated network, for the use of e-mail or e-mail plus low connectivity internet access for the whole department.
3. The two bands are used as contingency network back-up system; if one is temporarily interrupted for technical reasons the other one is used avoiding a break in telecommunication.
4. Enable automatic back-up system to be saved to the local server and to a remote back-up system that we recommended to be located in the DRR Resource Centre. For safety reasons, one of the back-up servers should always be located in a separate building.
5. Data storing system. This applies to the development and maintenance service that includes
    a. Creation of an appropriate database that differentiates administrative data from geoinformation data. Such a database should be developed and maintained by the same local IT company, contracted to provide the support for a period of no less than 24 months.
    b. Firewall protection system for the entire department network for 24 Months.

During the assessment it was observed that often donors and NGOs provide specific hardware often without the necessary installation support or an appropriate action to have the IT equipment integrated into an appropriate network. As a consequence, the supplies are either not used to their full extent and / or the department team is loaded with extra work to source the necessary skills to install the supplies. We therefore recommend that the purchases of technological supplies include a minimum maintenance service. Ideally the action should envisage to contract one IT service

company to develop the intranet network and provide the database and firewall support to maintain the GIS equipment such as scanners and plotters (if possible).

Fund for the purchase of remote sensing data:
Other than equipment and supplies, this intervention proposes to make provisions for purchasing remote sensing data including optical and radar data [†††] *. The objective is to generate accurate flood masks in the event of flooding. The importance of flood mask analysis was underlined during the recent Catchment Modelling Exercise conducted by Z_GIS and COOPI in the central region for the Lithipe and Lingazi rivers (presented during a workshop on 28-29 Sept 2011 in Lilongwe). Accurate flood extent information enables experts to measure the real extent of flood events and therefore contribute to a better vulnerability analysis at village and sub-village level. At the same time it offers valuable information to calibrate and correct flood modelling such as the one that COOPI and Z_GIS are currently developing and the one commissioned by the World Bank for the Shire River. Considering that flood masks can often only be made using radar sensors (due to prevailing cloud cover during flood events), we proposed the establishment of a 'fund' to be used to purchase specific area coverage in a timely manner once a flood occurs. This may imply framework contracts with provider companies to speed up data procurement. Ideally such framework contract may also include satellite images (visible spectrum) if the same provider identified is able to source them. These images may complement the respective advantages of radar vs. the visible data. In the table below we indicated some advantages of using Satellite radar sensor of some commercial sensors and useful links to have to complement the

	Optical Satellite imagery	**Radar**
Resolution	Various depending on sensors – up to 0,15 m	Various depending on sensors – up to 0,4 m
Example of sensors advised currently available	- Worldview 1 and Worldview 2 (0.46 m resolution) - operated by DigitalGlobe http://worldview2.digitalglobe.com/ IKONOS Satellite Sensor (0.8 meter resolution) – operated by GeoEye - GeoEye-1 Satellite Sensor (0.5m resolution) - operated by GeoEye http://www.satimagingcorp.com/satellite-sensors/geoeye-2.html - Spot 1,2,3,4,5, (2.5 m resolution) operated Astrium Landsat (15m for Landsat7 various sensors at various resolution) operated by NASA http://landsat.org/	- Terra SAR (up to 1 m resolution) http://www.astrium-geo.com/terrasar-x/ http://www.dlr.de/hr/en/desktopdefault.aspx/tabid-2317/3669_read-5488/
Sensor available in the next future	GeoEye-2 (>0.25 m resolution and vertical resolution higher than 0.5 m) Spot 6 and 7	TanDEM-X (below 0.4m resolution) and vertical resolution higher than 0.3 m
Possibility to use even with cloud cover	No	Yes
Possibility to obtain task and or archive data	Yes – timing of delivery of task operation between 2 and 25 days (depending on priority and position of satellite	Yes – timing of delivery of task operation between 2 and 25 days (depending on priority and position of satellite
Software to develop flood mask	Variety of software – none automatic to our knowledge	Yes available – semi automatic
Usefull for land cover / land change analysis	Various resolution (even low resolution / free data) provide excellent data) also for forest studies	Optimal for a variety of analysis.
Cost (USD / km2) for high resolution (prices depending on several variables)	Average 25- or more for task Less than 10-15 for archive	Average 30- or more for task Less than 10-15 for archive

Table 14 Generic overview of optical and radar sensors

[†††]In this document we refer to radar data what is called generally Synthetic-aperture radar (SAR) which is a form of radar whose defining characteristic is its use of relative motion between an antenna and its target region to provide distinctive long-term coherent-signal variations that are exploited to obtain finer spatial resolution than is possible with conventional beam-scanning means.

DRR Resource Centre as a service delivery point of the Survey department (primarily) and DODMA:
The DRR Resource Centre serves already as an information centre for DRR in Malawi and was established within the premises of the Department of National Park and Wildlife (DNPW) at the old Natural Sanctuary in the City Centre in Lilongwe in March 2011. This initiative was authorised and commended by the DNPW and DODMA. COOPI contributed to the rehabilitation and opening of the Centre. This was arranged with support from ECHO and is currently operating with some funds from DFID that will allow the use of this Centre for the next 5 years. COOPI is currently allocating further resources into the development of the DRR Resource Centre and has a technical room provided with basic IT equipment and a shared conference room. The DRR Centre already offers space to share didactic and educational material. We proposed to further use this Centre to serve as well as:

1. **'***GIS service delivery point for DRR and Climate Change activities***'** to which various stakeholders can come to print maps, collect and share geoinformation such as shapefiles and other geo data, and receive free technical support from a COOPI GIS officer
2. *Data backup system*. Hosting the backup server to store a copy of geo-data from the Survey Department and the DODMA**.** This is in line with the general principle to have a comprehensive back-up system in a separate building in order to avoid loss of data in case of fire or other major accidents.

Specific issues concerning the implementation modalities are listed in Annex 5.

4.2.2 Second short-term intervention

Key objective:
A Web GIS 'Atlas' for DRR and Climate Change adaptation planning is developed and maintained in Malawi.

This intervention is related to the following recommendations and activities of the long term plan:

Recommendation 1: The Malawi Geoinformation Council (MAGIC) is operational

1.1 update the statutes of MAGIC
1.2 compile the membership
1.3 develop an operational plan for MAGIC and the NSDI (for 2012)
1.4 organise and hold regular meetings (in 2012)

Recommendation 4: An inventory of existing spatial data is established compliant to SDI standards

4.1 design web-based meta-data form and database
4.2 inform all relevant departments about use of form and specifications required
4.3 implement data transfer policy (e.g. web-server)
4.4 upgrade the technical infrastructure to provide geospatial baseline data at Land Survey Department and DODMA (e.g. DEM, roads, settlements, etc.); *already incorporated in the short term intervention 1, see above.*
4.5 design and establish a national web-GIS platform as a service delivery point (e.g. at DRR-Centre)

Recommendation 5: A Climate Change Atlas on key drivers in Malawi is compiled and regularly updated

5.1 define the key change drivers for Malawi (main chapters of Atlas)

5.2 develop a concept for the integration of relevant data layers (hazards, vulnerabilities) on national scale
5.3 reach consensus on scenarios to be used (climate change, development agendas)
5.4 implement the atlas on the national web-GIS platform (see 4.5)
5.5 provide hardcopy brochures with explanatory notes for decision makers and schools
5.6 ascertain regular updates of the atlas

Recommendation 6: Vulnerability assessments in support of DRR and CCA are carried out for 2 most affected districts (Nsanje and Salima)

The following activities are related to the outcomes 5 and 6 of the overall long term recommended intervention and will enable one to compile and publish online a series of vulnerability maps for two districts. The Atlas will therefore offer a digital platform to share data/information and represent an exchange platform for advocacy with the objective to scale up the same methodology to other districts.

5.1 define the key change drivers for Malawi (main chapters of Atlas)
5.2 develop concept for the integration of relevant data layers (hazards, vulnerabilities) on national scale
5.3 reach consensus on scenarios to be used (climate change, development agendas)
5.4 implement the atlas on the national web-GIS platform
5.5 provide hardcopy brochures with explanatory notes for decision makers and schools
5.6 ascertain regular updates of the atlas
6.1 adapt vulnerability framework for conditions in Malawi integrating DRR, CCA and livelihood approaches
6.2 develop critical set of indicators and compile required data (incl. remote sensing, socio-economic, population, geospatial baseline data)
6.3 model vulnerability domains by integrating expert knowledge.
This action will include the application of a defined methodology already developed by Z_GIS and applied in other African Countries.
6.4 visualise results and indicators as part of the national web-based atlas.
This activity includes a training component for the DODMA officers at central and district level (min 20 people) to enable them to (a) appropriately collect the data and feed the database and (b) use the database in an interactive way.

Attention: Activities 4.3, 5.3, 5.5, 5.6 are only partially achievable in a short-term intervention. This specific intervention will address some feasible components of these activities necessary to achieve the primary outcome to generate a WEB GIS Atlas for DRR and CCA. However without thoroughly incorporating all the activities recommended in the long-term intervention, we cannot ensure that the data sharing policies and continuous update of the Atlas will be sustainable.

Some of the ATLAS characteristics

A. Being developed using open source software and envisioned to be modular and flexible
B. All the data from EWSs are stored and accessible online. Incorporate a Central EWS Database including accurate historical trends of the measurements from the various stations (water gauges, rain gauges, etc.) stored along with historical flood event disaster, damages reported. The atlas should also include a detailed map of the station to be maintained / repaired.
C. Integrate Climate Change data and meteorological ATLAS in one single system
D. Provide automatic warning signals from the automated stations to the DODMA officer at District and central level and possibly to the relevant NGOs (using automatic SMS and e-mail)
E. Incorporate scenario based and flood modelling developed by various stakeholders
F. Incorporate automatic data collection / transmission and visualization from meteorological stations and seismographers.

G. Integrate relevant layers such as population density, topographic and morphological information.
H. Enable historic analysis of previous record, warning, hazards and vulnerability factors.
I. User-friendly modalities to generate / customize / print maps.
J. Possibility to upload data easily AND link with the Water and Climate Change and Met. Dept.
K. Monitor the current status of the EWS and Identify specific gaps / needs
L. Enable off-line visualisation of specific sets of data
M. Enable rapid mapping using Google Earth technology
N. Enable the District Dodma officer to upload and download in real time geo-referenced information and pictures related to rapid assessment.
O. All the available data mentioned above should be made accessible previous authorising from the relevant stakeholders and possibly in line within the framework of a Spatial Data Infrastructure (please refer to chapter 4)

Methodologies recommended to develop the ATLAS

1. Revamp and use MAGIC platform and the NSDI to reach a participative consensus with the key expert in Malawi, particularly the Survey Department, the DODMA and the Climate Change Adaptation Committee. Direct involvement of University, particularly Bunda College in the discussion.
2. The ATLAS will become therefore one key reason to facilitate meetings with a concrete objective to develop a functional Atlas and at the same time promote the first steps to initiate the SDI process.
3. Progressive process to develop the Atlas
    - Design first version of the database structure.
    - Consultative meeting to present the first draft database structure.
    - Revision (tuning) of the database.
    - Integration of collected data in activity into the database underlying the WEB GIS Atlas.

We recommend to use the above information as term of reference for such activity. Refer also to section 3.2.2.2 and Box at page 47

Cost of intervention 2

App. 290.000 USD
We believe that this amount allows the development of the Atlas and the start of the process of vulnerability mapping in specific areas. However, please note that this budget is purely indicative and needs to be detailed in the course of a detailed programming of the activities and with the participation of the implementing agency involved.

Implementation time frame: 12 Months starting from January 2012.

Specific issues concerning the implementation are listed in Annex 5.

5 ANNEX

Annex 1 References
Annex 2 Questionnaire
Annex 3 Maps
Annex 4 Implementation modalities of the short-term intervention
Annex 5 Logical framework of the long-term intervention
Annex 6 Term of Reference of a GIS / RS expert for CCA and DRR in Malawi
Annex 7 Training Modules for GIS and RS
Annex 8 Recommended purchases for the long term and short-term interventions
Annex 9 Some information of the consultant team

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ANNEX 2 – Questionnaire

Semi-structured Questionnaire

DATE: _____

UNDP Climate Change Adaptation Study

semi-structured interviews at national level (Malawi)

1) General information

1. What is the name/address/website of your agency/institution/department/unit?
2. What is the mission of your agency/institution/department/unit?
3. Contact details of person interviewed (name, position, email, etc.)

2) Natural hazards/historic hazard events (focus on flood hazards)

Which/where have been the most severe (flood) hazard events in the past decades (specify location on the base map)

4. When do these hazards (flood events) usually occur? Are there geo-climatic patterns that are linked to extreme events (such as El Nino/La Nina years, tropical cyclones, etc.)
    - Yes → details
    - No

5. Is there a link between global climate change and increased hazard frequency/hazard risk/hazard severity (particularly concerning floods)
    - Yes
    - No

6. Are there areas/regions/districts/communities which are frequently affected by natural hazards (particularly flood events)? Which areas are particularly vulnerable to flooding (locate on the base map)?

3) Early warning systems (EWS)

7. Is there/are there EWS in place in Malawi?
    - If yes,
        - Where exactly? (can you locate it on the map
        - Is it a single or a multi-hazard EWS?
        - Who installed the EWS?
        - Who paid for it (funding)?
        - When has the EWS been set up?
        - Who is operating/maintaining the EWS?
        - Who is coordinating the warning activities?
        - Which are the most important institutions involved in early warning in Malawi?
        - Is your agency/institution/department/unit also involved in early warning activities?
            - Yes → details:
            - No
        - Are the existing cooperation's between/with relevant institutions
    - How does the existing EWS work?
        - Who is monitoring which indicators and how?
        - Which indicators/models are utilised for hazard (flood) prediction?

- How are early warning messages communicated to the district/local level? Is there a centralised or a decentralised EW-structure in Malawi?

- Has the local population/local experts been trained (community-based early warning)?
  - Yes → by whom and when?
  - No → why not; is this planned?

- How would you rate the effectiveness of the existing EWS? Explain.
  - Very high
  - High
  - Low
  - Very low

- What are the major strengths/weaknesses of the existing EWS?

- What could/should be improved to reduce hazard (flood) risk?

- If no,
  - Are there plans to install an EWS in the future?
    - Yes
    - No

  - Who is coordinating the planning efforts?

  - Who is paying for the EWS (funding, partnerships)?

  - Who will be responsible/in charge of the operation/coordination of the EWS?

  - Are there any plans how to communicate early warning messages to the local level?

  - Will there be a training of the local population (community-based EWS)?

4) Anthropogenic impacts on flood severity/flood risk

8. Which are the main drivers having an impact on flood risk in Malawi (e.g. population pressure, catchment degradation, etc.)

9. How would you rate the importance of land use changes, population growth, etc. for increased flood risk in Malawi? Explain:
   - Very high
   - High
   - Low
   - Very low

10. Do you have any reports/documents/etc. justifying these suggestions/statements (with regard to the importance of land use changes, etc.)? Is it possible to get a copy?

5) Disaster risk reduction (DRR) and recovery activities

11. Who/which institution has the official mandate for interventions in the field of DRR in Malawi?
    - Name/contact details
    - Is your agency/institution/department/unit also involved in DRR and recovery activities?
        - Yes → details
        - No
    - Are there existing cooperation's with other relevant institutions?
        - Yes → with whom (contact details), since when?
        - No → is this planned for the future?
12. Which are the most important policies regulating DRR and DRR-related planning activities and responsibilities in the field of DRR?
13. Have there been any interventions in flood DRR in the past (river management, dams, etc.)?
    - Yes
        - → Which interventions have been made by whom (government, donors, NGOs, communities, etc.), where and when?
        - Did the interventions result in reduced flood risk? Experiences?!
        - What are the strengths/weaknesses of the existing interventions?
        - What could/should be done to improve the effectiveness of existing interventions?
        - Are there plans for further investments in this field?
            - Yes → details
            - No
    - No (there have been no interventions so far),
        - Are there any plans for investments in interventions in the field of disaster risk reduction in the next years? Details?!
14. What is currently done and could/should be done to:
    - Reduce risk from natural hazards (particularly flood risk)
    - Mitigate the consequences of natural hazards (particularly flood risk)
15. Are there any plans for investments (who, with whom, where, what, when, funding)?

6) Climate Change, vulnerability and disaster risk reduction (DRR) related projects

16. Is your agency/institution/department/unit currently working on any vulnerability/climate change adaptation/DRR projects or has been working on DRR projects in the past?
    - Yes
    - No

17. On which phase of the disaster cycle did your projects/do your projects concentrate?
    - Disaster
    - Response
    - Recovery
    - Mitigation
    - Risk reduction
    - Prevention
    - Preparedness
    - Other: _____

18. On which hazards did/does the work of your agency/institution/department/unit concentrate?
    - Floods
    - Drought
    - Earthquakes
    - Cyclones
    - Wildfires
    - Landslides
    - Other: _____

19. On which level does your agency/institution/department/unit primarily work?
    - Regional
    - National
    - Sub-national
    - Community

7) Geoinformation for DRR

20. Does your agency/institution/department/unit have any staff experienced with geoinformation (GIS, remote sensing, etc.)
    - If yes,
        - how many employees does this unit have?
        - What is their academic background (education level)?
        - Who is the head of the unit (contact person)?
        - Since when (month/year) is she/he the contact person?
    - Is there someone in your team dealing 'exclusively' with GIS/remote sensing?
        - Yes (list of names and contact details):
            - _____
            - _____
            - _____
            - _____
            - _____

- No → why not?

- Who is the person responsible for GIS for DRR and climate change adaptation measures?

21. In which field(s) is your agency/institution/department/unit working/has your agency/institution/ department/unit worked with geoinformation so far?

22. Does your agency/institution/department/unit have any experience in applying geoinformation (map products, satellite and GIS data) in the context of hazard/vulnerability mapping and climate change adaptation measures?
    - Yes → Details:
    - No → why not?

23. Which software is commonly used in your agency/institution/department/unit? (→ inventory list of available/utilised software packages)
    - _____
    - _____
    - _____
    - _____
    - _____
    - _____
    - _____

24. How many persons are working with the software?

25. Do you have an inventory list of the hardware which is available for geospatial analysis in your unit (number of PCs, laptops, GPS receivers, etc.)?

26. Which hazard/vulnerability related products (maps, statistics, reports, etc.) are/were produced/published by your agency/institution/department/unit?

27. Who created these products? (name and contact of the person in charge, team leader, etc.)

28. What types of maps does your unit mainly use/produce (static vs. dynamic maps)? Is it possible to see some examples of previous work/maps that were used/produced?
    - Static maps (paper maps, digital maps as PDF files, etc.)
    - Dynamic maps (Google Earth, Web GIS, etc.)
    - Both

29. How would you rate your agency's/institution's/department's/unit's geoinformation capabilities?
    - Very high
    - High
    - Low
    - Very low

30. How would you rate your level of experience in the field of geoinformation for DRR?
    - Expert,
    - Advanced

- Beginner
- Not experienced

31. What are the major limitations/obstacles your agency/institution/department/unit is currently facing with respect to earth observation/GIS-based hazard/vulnerability mapping capacities?
    - Financial resources (to do what)
    - Expertise
    - Knowledge
    - Hardware
    - Software
    - Data
    - Maps
    - Other: _____

32. What would you say are the agencies current needs with regard to GIS/earth observation capabilities for climate change adaptation? Where do you see potentials/opportunities (also in regard to coordination issues between institutions) and threats?
    - Needs:
    - Potentials:
    - Threats:

8) Spatial Data Infrastructure (SDI)

33. Do you know what SDI stands for?
    - Yes
    - No

34. As far as you know how is your agency/institution/department/unit contributing to SDI in Malawi?

35. Who is responsible (has the mandate) for SDI in Malawi (contact details)?

36. What do you think about the SDI in Malawi (strengths/weaknesses/opportunities/threats)?

37. How would you rate the current internet (upload/download) capacity in your agency/institution/ department/unit
    - Very high
    - High
    - Low
    - Very low

9) GIS and earth observation data

38. Can you describe the type of geo-data (GIS data, remote sensing data, GPS data, etc.) available?

Type of data including **updates** of these data,	**How** and **when data** were **collected / acquisitioned**	**Use**	**Soft copy**	**Hard copy**	Who is **responsible**

39. Is it possible to get an inventory list of the datasets which are currently available at your unit/agency? (If they do not have a list available, is it possible to get it via email?)

40. Do you have a backup system, etc. to make sure the data cannot get lost? How does it work?
    - Yes
    - No → why not? Are there any plans to establish a backup system in the future?

41. Do you have metadata for these datasets?
    - Yes
    - No → why not?

42. Is there an internal position dedicated to updating/creating metadata?
    - Yes
    - No → why not/is this planned?

43. Does your agency/institution/department/unit share these datasets?
    - Yes → can you explain which datasets are shared and how?
    - No → why?

44. Can you give some examples of previous data sharing (with whom data was shared and how)?

45. What is your opinion concerning Web GIS Atlases (strengths/weaknesses)?

46. Do you know if Malawi is operating such a Web GIS Atlas?

47. How could/should such a Web GIS Atlas be designed/improved?

48. Where do you see potentials/opportunities and potential threats or conflicts with regard to such an Atlas?

10) Cooperation's/partnerships

49. Does your agency/institution/department/unit have any cooperation with other agencies/institutions/departments/units/NGOs working in the field of DRR or geoinformation?
    - Yes → contact details (name, address, contact person, website, etc.)
    - No → why not/is this intended?

50. Does your agency/institution/department/unit produce any kind of maps for other institutions?
    - Yes (details: which kind of maps, for whom, when, in which context)
    - No → have you planned to produce maps for other institutions in the future?

- Yes
- No

51. Did you request/benefit from external support to produce maps for your office?
    - Yes → from whom? Which kind of support? Who paid (funding)? Were you satisfied?

    - No → have you planned to request external support in the future?
        - Yes
        - No

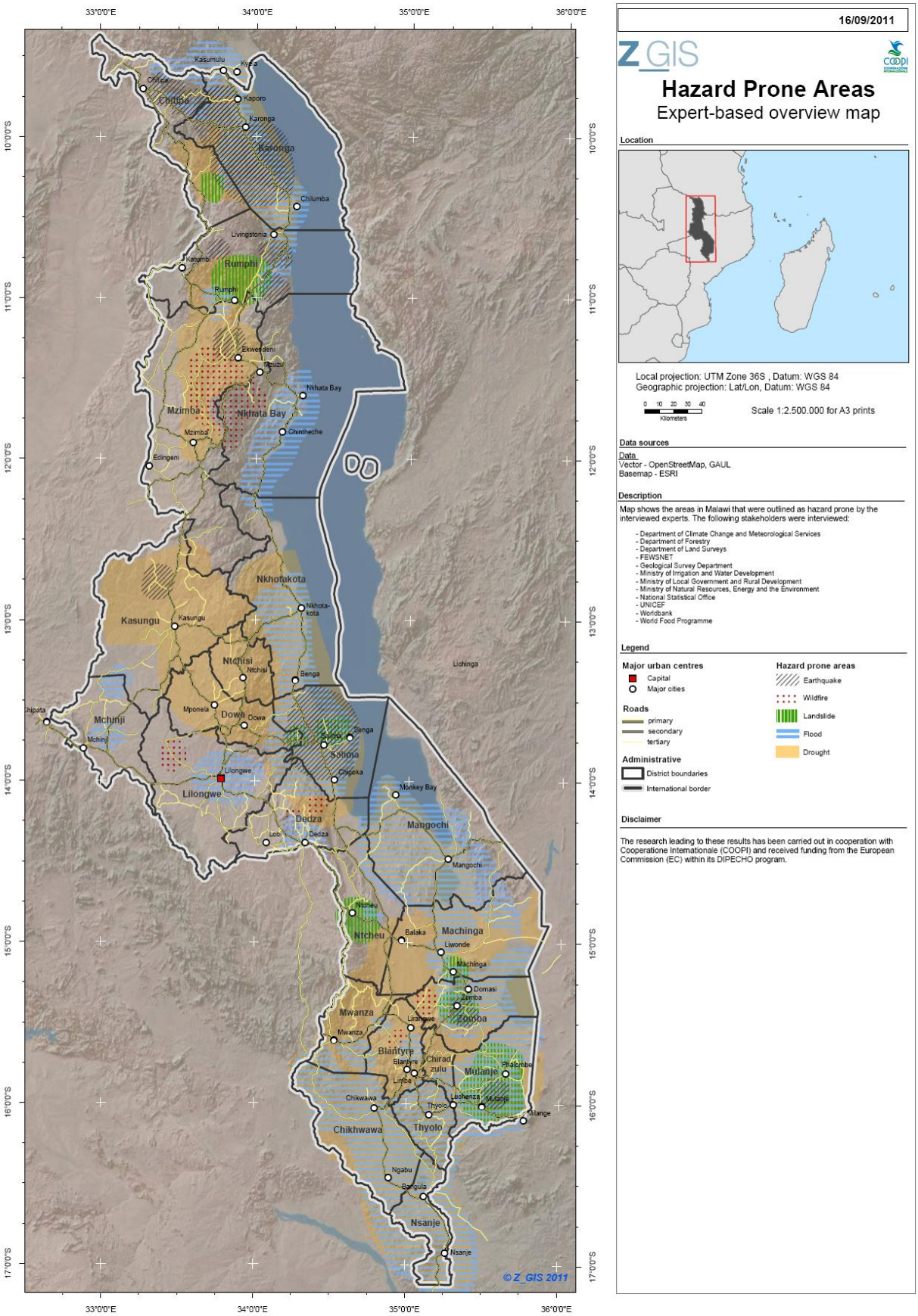
52. Do you think the current cooperation between institutions is appropriate and satisfactory to address climate change and DRR in Malawi? Explain:
    - Yes

    - No

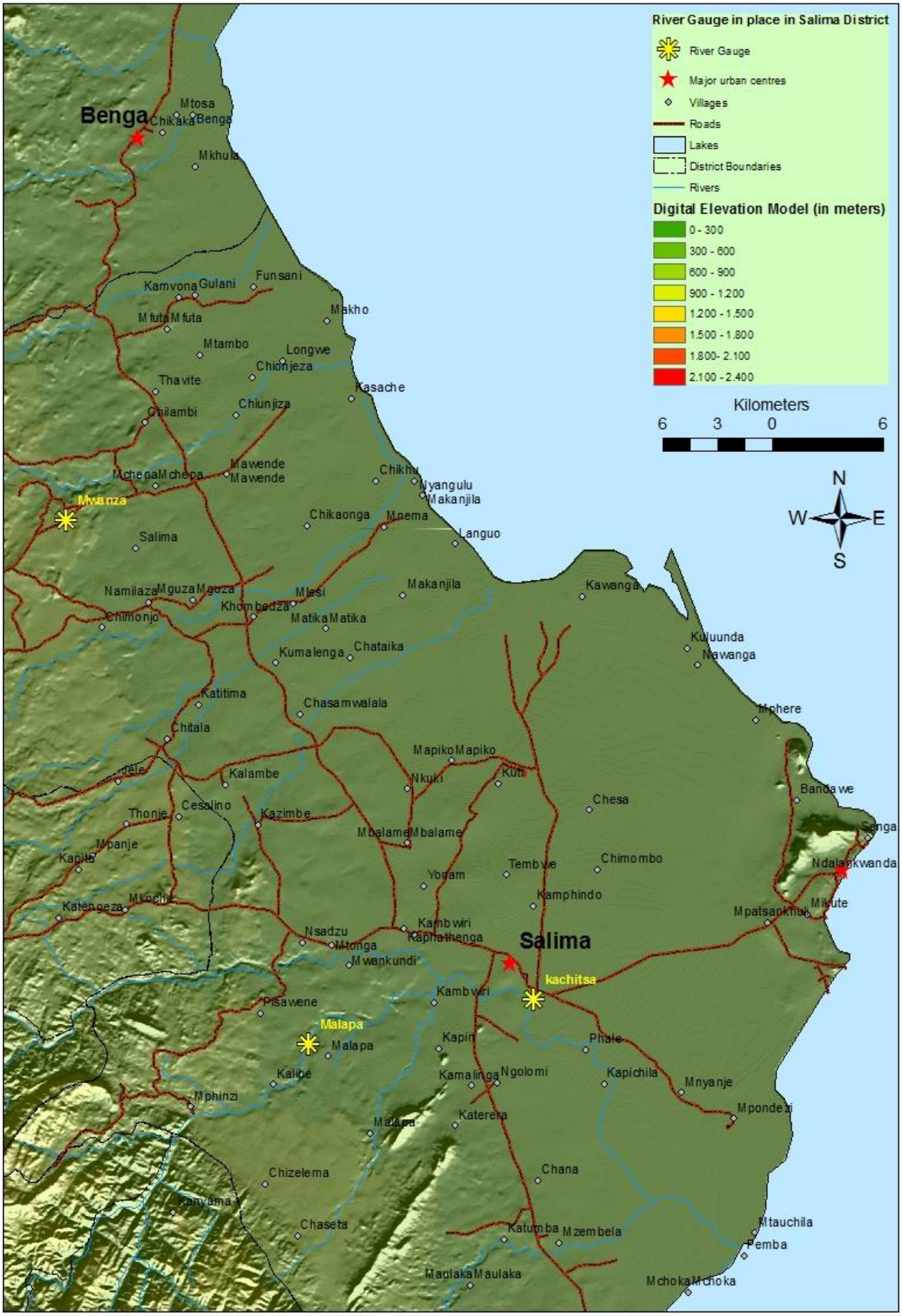
53. What would be your recommendations to improve it (guide the answer concerning geo information data)

11) Additional comments

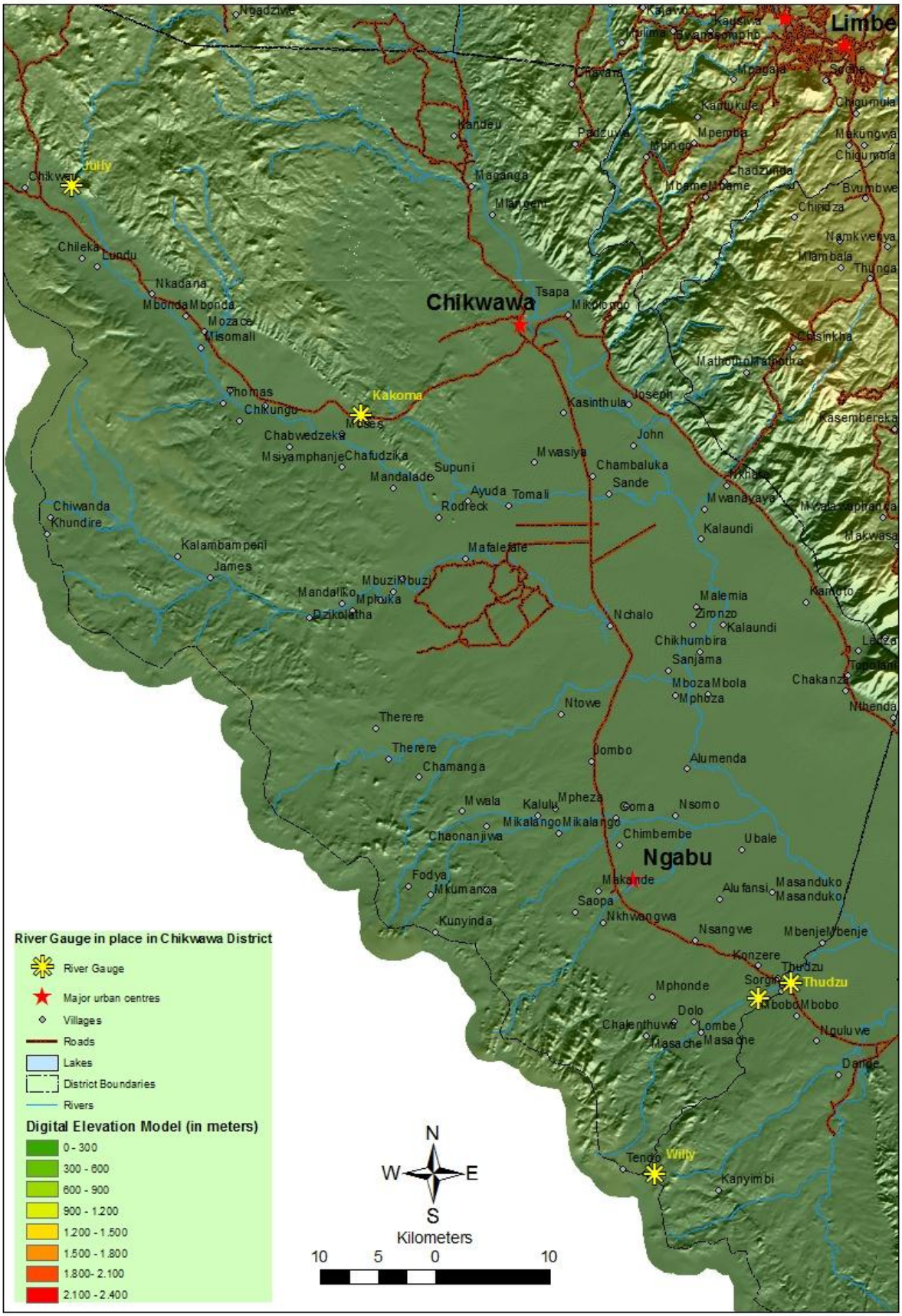
ANNEX 3 – Maps



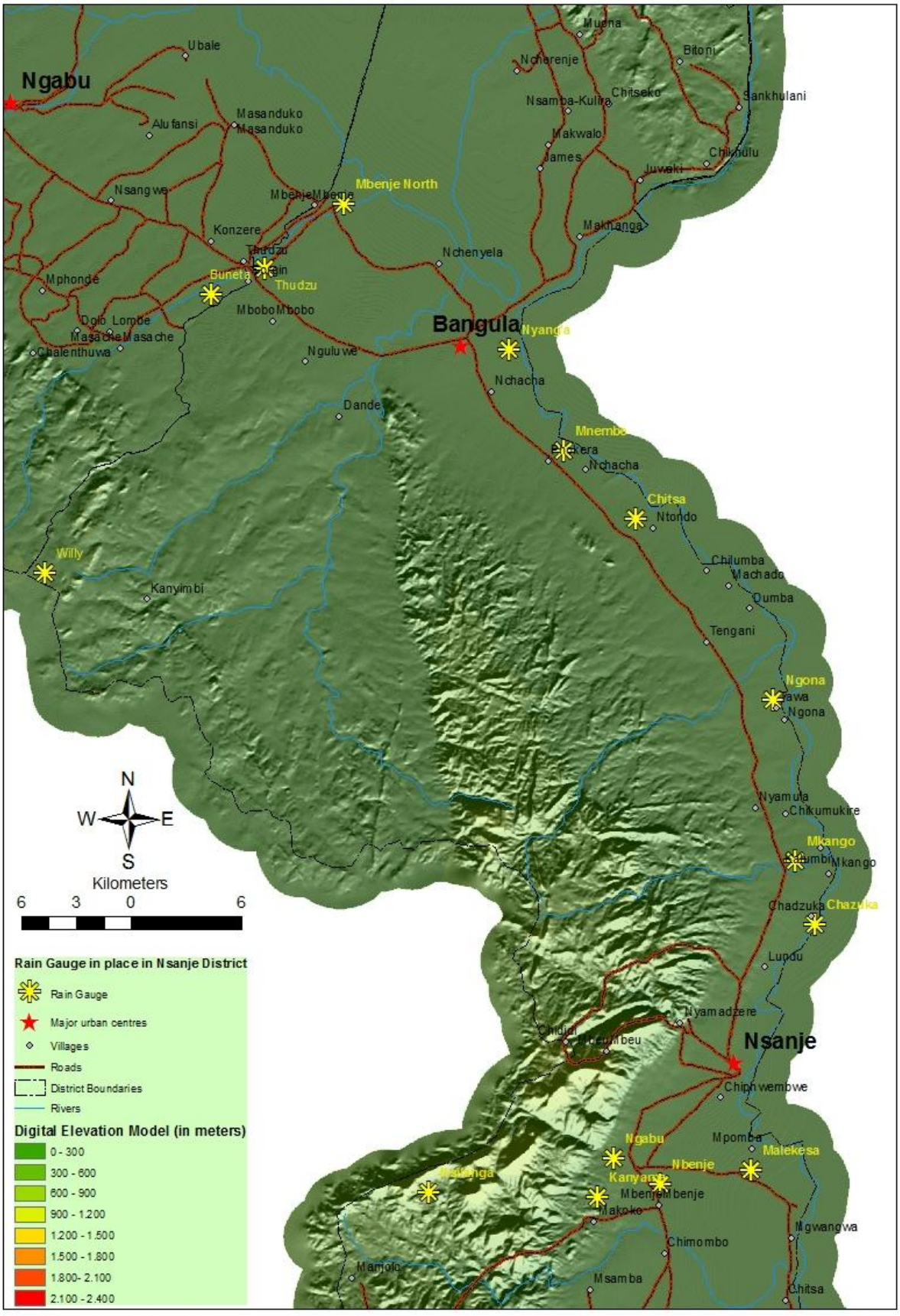
Annex 2 - Map 1: Hazard prone areas (based on expert-knowledge)



Annex 2 - Map 2: Flood early warning system (EWS) in Salima district



Annex 2 - Map 3: Flood early warning system (EWS) in Chikwawa district



Annex 2 - Map 3: Flood early warning system (EWS) in Nsanje district

ANNEX 4 – Implementation modalities of the short term intervention

Insurances and courier / transport costs:
All the items should be comprehensively insured. In the table provided we have estimated the cost of insurance. Similarly we have included costs for courier / international transport.

Modality of implementation of short-term intervention 1

We propose 3 possible modalities / options to perform the above mentioned short-term intervention concerning the equipment of GIS tools.

Option 1
The funds are directly administrated by UNDP to purchase the supplies and identify the service delivery companies (particularly for the IT / internet and database creation and maintenance)
Advantages of this option are

- Direct control of the financial resources
- Probably the taxes exemption is facilitated

Disadvantage

- Time and personnel consuming due to work load associated to the procurement procedures
- Risk to purchase items that are not perfectly matching the technical requirements

Option 2
The funds are given to the various beneficiaries' institutions / departments

Advantage of this option are

- Each offices / department make its on choices and report directly to the donor.

Disadvantages

- Time and personnel consuming due to workload associated to the procurement procedures. This amount of time and workload may negatively affect the entire process and the day-to-day work plan of the government staff.
- Risk of delays due to procurement procedures
- Risk to purchase items that are not perfectly matching the technical requirements (observations made by few department officers during the interviews)
- Some fund not fully used in time

Option 3
UNPD select a contractor agency that will implement the full equipment and service delivery. Ideally an NGO based in Malawi.

Advantages of this option are

- Direct control of the financial resources tough an audit (internal and external audit) ensured by the project and the Tax exemption should be relatively easily extend to the NGO as a non-profit organisation partner of UNDP
- A dedicated team is ensuring timely and quality delivery avoiding time loss of the various departments and the donor. Constrains and problem are solved by the contractor agency / NGO.
- A small training package is offered to each beneficiaries
- Enable to create a single common and harmonised data back-up and network system linking the survey department and DODMA to the DRR Resource Centre.
- allows to integrate in one single project this specific short intervention with the second short term intervention (see below) aimed to produce Maps and Atlas optimizing the resources.

Disadvantages

- an incremental cost for the project management is required (approximately 15% of the entire budget)

- marginal risk associated to a wrong perception from the beneficiaries that the equipment are part of a classic hand-outs program implemented by various NGOs (this could be avoided with adequate presentation of the action)

Implementing time frame

Table 1 Recommended time frame of the intervention

Activity	Months				
	1	2	3	4	5
Signature of agreement with the institutions (option 2) or with the NGOs (option 3)					
Detailed procurement plan and quotation collection					
Purchase and database development					
Delivery and installation					
Minor training component for each beneficiaries (included in the option 3)					

Modality of implementation of short-term intervention 2

We recommend adopting a consultant team or NGO that have the following characteristic

1. International proven experience in GIS and development of Web GIS Atlas
2. Proven experience in direct vulnerability mapping.
3. Having a permanent presence in Malawi and involving a combination of local and international expertise with a general aims / interest to further develop the local skills.
4. Possibly having familiarity with Malawi rural setting and physical presence within the districts targeted.
5. Having a strong academic background / support could be a positive advantages.

ANNEX 5 – Logical framework of the long term intervention

A long-term program aimed to develop an effective SDI and the related capacity building framework in Malawi supporting the planning, implementation and evaluation of national DRR and CCA programmes.

In the section below we present an extrapolation of a logical framework that could be used to design the long-term intervention proposed by the consultant team

	Intervention logic	**Objectively verifiable indicators of achievement**
Overall objectives	Informed decision making paves the way for sustainable development in Malawi	*What are the key indicators related to the overall objectives?*
Specific objective	An effective SDI and related capacity building framework is existing in Malawi supporting the planning, implementation and evaluation of national DRR and CCA programmes	1. An SDI Act is adopted by Parliament by 2013 2. Malawian geoinformation experts are leading the use, increased adoption and enhancement of GIS and RS in the country by 2013 3. The Atlas (Climate Change, DRR) is a key information source for development planning by 2014
Expected results	R1: The Malawi Geoinformation Council (MAGIC) is operational R2: SDI principles and guidelines are formulated for Malawi with the support of SDIAfrica R3: Advocacy on SDI principles carried out R4: An inventory of existing spatial data is established compliant to SDI standards R5: A Climate Change Atlas on key drivers in Malawi is compiled and regularly updated R6: Vulnerability assessments in support of DRR and CCA are carried out for 3 most affected districts R7: Academic institutions build local capacity to manage and integrate geoinformation for development in Malawi R8: Capacity building measures are developed and provided at institutional level	| 1 Statutes published, membership list regularly updated, minutes of meetings | 2 documents on SDI, policy document, SDI workshop, meeting attendance | 3 dissemination material + media products, conference, regular evaluation reports | 4 Inventory of Geo Data in place | 5 Atlas online with record of regular updates | 6 Vulnerability maps uploaded in the Atlas | 7 Number of Students enabled in Malawi to use GIS and RS | 8 Number of Expert in government department (i.e. Survey Dept) are enabled to carry on SDI activities

Activities

Result 1) The Malawi Geoinformation Council (MAGIC) is operational

1.1 update the statutes of MAGIC
1.2 compile the membership
1.3 develop an operational plan for MAGIC
1.4 organise and hold regular meetings

Results 2) SDI principles and guidelines are formulated for Malawi with the support of SDIAfrica

2.1 compile existing legal documents and update inventory of implementation papers & studies
2.2 draft principles on data sharing by exploring the Implementation Guide provided by SDIAfrica
2.3 organise workshop with government experts and experts from SDIAfrica
2.4 adopt policy document on SDI principles in Malawi
2.5 attend meetings on regional and international level (CODIST, AfricaGIS, AARSE, etc)

Results 3) Advocacy on SDI principles carried out

3.1 create information products for awareness building on SDI (folders, brochures, slide shows, posters)
3.2 hold awareness events (seminars, workshops) for government institutions
3.3 realise a series of newspaper articles, radio features and TV interviews on SDI
3.4 organise a regional conference jointly with SDIAfrica in Lilongwe
3.5 ascertain compliance with SDI standards and principles for government and donor projects (e.g. external evaluation)

Results 4) An inventory of existing spatial data is established compliant to SDI standards

4.1 design web-based meta-data form and database
4.2 inform all relevant departments about use of form and specifications required
4.3 implement data transfer policy (e.g. web-server)
4.4 up-grade the technical infrastructure to provide geospatial baseline data at Land Survey Department and DODMA (e.g. DEM, roads, settlements, etc.)
4.5 design and establish a national web-GIS platform as a service delivery point (e.g. at DRR-Centre)

Results 5) A Climate Change Atlas on key drivers in Malawi is compiled and regularly updated

5.1 define the key change drivers for Malawi (main chapters of Atlas)
5.2 develop concept for the integration of relevant data layers (hazards, vulnerabilities) on national scale
5.3 reach consensus on scenarios to be used (climate change, development agendas)
5.4 implement the atlas on the national web-GIS platform (see 4.5)
5.5 provide hardcopy brochures with explanatory notes for decision makers and schools
5.6 ascertain regular updates of the atlas

Results 6) Vulnerability assessments in support of DRR and CCA are carried out for 3 most affected districts

6.1 adapt vulnerability framework for conditions in Malawi integrating DRR, CCA and livelihood approaches
6.2 develop critical set of indicators and compile required data (incl. remote sensing, socio-economic, population, geospatial baseline data)

6.3 model vulnerability domains by integrating expert knowledge
6.4 visualise results and indicators as part of the national web-based atlas

Results 7) Academic institutions establish a GIS / RS Centre and build local capacity to manage and integrate geoinformation for development in Malawi.

7.1 The GIS / RS Centre (within Bunda College) is equipped with and maintains teaching, training and working facilities for the delivery of quality training and research
7.2 Develop a curriculum and associated courses to serve the different needs in geoinformation within GIS / RS Centre
7.3 Ascertain human resources having the capacity to respond to the educational and research tasks
7.4 Establish collaborations and links within a national, regional and international context in regard to building capacity for teaching and implementation of research projects
7.5 Carry out research and outreach activities to support the improvement of a national spatial data infrastructure and climate change issues in Malawi

Results 8) Capacity building measures are developed and provided at institutional level

8.1 design a SDI curriculum for experts
8.2 data standards and meta databases
8.3 GIS concepts
8.4 data integration
8.5 award for SDI champion on a yearly basis

The overall costs estimated for the full implementation are to be set at a minimum of USD 2,800,000 to ensure adequate management and national/international facilitation and participation to related events. The duration will be 3 years at minimum.

ANNEX 6 – Term of reference of GIS and RS Officer for CCA and DRR

Duty Station: Lilongwe (we recommend the DRR Resource centre)
Supervisor: to be defined by the CCA committee (we recommend the chair person)

1. Catalogue and manage Geo data in collaboration of the Survey Department
2. Digitized and geo referenced analogues data
3. Define a clear methodology of data archive, Metadata and back up system and ensure its implementation
4. Design and update maintain the assets inventory lists
5. Ensure back up
6. Purchase remote sensing and geo data
7. Prepare / assist to prepare year budget for GIS and RS activities
8. Support the preparation of Term Of References for consultants and external interventions
9. Follow up external consultant
10. Facilitate and participate to any SDI activities mandated by MAGIC
11. Participate to national and international workshop relative to national and /or international GIS / RS initiatives.
12. Support the establishment of the GIS /RS centre and collaborate with the Universities to promote specific practical research program useful to enhance the use of GIS and RS for CCA and DRR in Malawi (possibly serve as co-supervisor of the MSc Students)
13. Contribute to identify funds opportunity for GIS and RS for Malawi CCA and DRR program
14. Write report
15. Conduct field data collection and supervise specific surveys.
16. Training and capacity building of the CCA committee members and other stakeholders
    - Provide day to day technical support and on job training to the DODMA and other Department officer
    - Prepare training materials for the theory part of the training which must be handed to the trainers both as hard copy and digital
    - Prepare and bind training manuals for the RS and GIS training equivalent to the trainers number. The manuals must be hard copy and digital
    - Fully train on the use of ArcGIS 10, its tools, Extensions, ArcCatelogue, meta data creation and database management and data analysis
    - Thoroughly train on the use of ERDAS or ENVI in processing of Remote sensing data, image interpretation and analysis
    - Identifying required extension of GPS, RS, and GIS and install the trainers PCs
    - Install required GPS, RS and GIS software in the trainers PCs
    - Make assessment on the trainers performance during training
    - Report writing

Qualification and experienced required

MSc in GIS – Cartography
At least 5 year experience in the majority of the above mentioned duties
Proficient in English and at least another UN language
Excellent knowledge of at least 3 GIS packages including ARCGIS
Excellent knowledge of web system and open source technologies is an advantage
Excellent team player

ANNEX 7 – Training Modules

REMOTE SENSING TECHNOLOGY AND ITS APPLICATION
TRAINING MODULE FOR BEGGINERS
COMPONENTS: *Theory* and *Practical*
REQUIREMENTS: Back ground in
DURATION: 11 Days

MODULE	CONTENT	PERIOD
Mod 1. Theory Introduction to GIS	What is GIS Components of GIS GIS data sources Functions of GIS Types of GIS data Types of spatial data Data creation in GIS Data entry in GIS GIS data management Spatial operations in GIS	1 day
Mod 2. Practical Introduction to ArcGIS 10	• The ArcGIS software ➢ What is the ArcGIS system ➢ Introduction to the ArcGIS software (ArcMap, ArcCatelogue and ArcToolbox ➢ Introduction to ArcMap's , map documents (Layout, view, data view and other key elements ➢ Working with map documents (Data frames, the layout, tables and graphs ➢ The Geographical User Interface (Managing the toolbars) • The ArcCatelogue and Arc Toolbox Applications ➢ The ArcCatelogue application ➢ Accessing and controlling ArcCatalog ➢ Creating and managing data in ArcCatalog ➢ Previewing spatial and attribute data in ArcCatalog ➢ Metadata: Viewing, creating, editing and managing ➢ Data properties: Structure, fields and indexes ➢ Managing data with ArcCatalog ➢ The ArcToolbox, what is it ➢ Accessing ArcToolbox and its tools ➢ ArcToolbox to create and manage projections and for spatial analysis • Map Documents and adding data ➢ Managing map documents ➢ Optimum page set up and management ➢ Creating data frames and their properties ➢ Activating data frames and managing the table of contents ➢ Valid spatial data formats ➢ Adding data directly and ordering data layers ➢ Group layers: Generating, managing ➢ Generating layer files ➢ Removing data ➢ Saving map documents • Symbolising spatial data ➢ Symbology properties ➢ Symbol selector for point makers, line styles and polygon fill patterns ➢ Choosing a legend type: Unique values (all and specific values), quantities (graduated, symbols) and chart ➢ Data classification methods ➢ Custom classifications	10 days (Two weeks)

	➢ Creating custom legends ➢ Customising legend labels ➢ Creating layer files to store symbology ➢ Transparency • Using spatial data ➢ Controlling the data and setting the scale ➢ Scale ranges to manage visibility ➢ Scale thresholds for data layers ➢ Display extent tools for layers, groups and sub groups ➢ Full extent tool ➢ Measure tool ➢ Identify tool ➢ Creating and managing bookmarks ➢ Magnifier window ➢ Viewer window ➢ Overview window • Expressions and managing attribute table ➢ Select by attributes dialog ➢ Attribute selection methods ➢ Building SQL's and SQL verification/ syntax ➢ Expression files ➢ Find function ➢ Layer definition queries • Creating and managing dynamic labels ➢ Dynamic label options: Method and label field ➢ Labelling styles and symbol styles ➢ Label placement for point, line and polygons ➢ Managing duplicate labels, orientation, angle, ordered placement ➢ Label conflict detection: Feature weight, label weight ➢ Label visibility, scaling and scale ranges ➢ Layer files for dynamic label management • Creating layouts and layout (Map) templates ➢ Defining a layout page ➢ Managing layout grids, guides, rulers and margins ➢ Setting and managing the map scale ➢ Managing scale bars and scale text ➢ Creating and managing extents for data location ➢ Managing tables and adding tables to layouts ➢ Adding and managing frame and map neatlines ➢ Adding pictures, north arrows, title text and graphics ➢ Adding/managing legends with the legend wizard: properties, styling, legend formatting ➢ Layout printing and exporting ➢ Creating and using map templates • Spatial and attribute editing ➢ Creating new data files (Shapefiles) from scratch ➢ Defining the field structure of new shapefiles ➢ Editor tool bar: managing an edit session ➢ Editing tasks ➢ Controlling the edit display ➢ Snapping environment: enabling and tolerance ➢ Creating new point, line and polygon features: mult-part and appending ➢ Managing the display ➢ Ending edit session and saving edits	

Table A 7a Training Modules on GIS

REMOTE SENSING TECHNOLOGY AND ITS APPLICATION
TRAINING MODULE FOR BEGGINERS
COMPONENTS: *Theory* and *Practical*
REQUIREMENTS: Back ground in either Physics, Mathematics, Computer science, Geography, environmental sciences
DURATION: 11 Days

MODULE	CONTENT	PERIOD
Mod 1. Theory Fundamentals of RS	▪ What is RS ▪ Principles of RS ▪ Electromagnetic radiation ▪ Electromagnetic spectrum ▪ Interactions with the atmosphere ▪ Radiation_ Target ▪ Active vs passive sensing ▪ Characteristics of images	2 days
Mod 2. Theory Sensors	▪ On the Ground, In the Air, In Space ▪ Satellite characteristics ▪ Pixel size and scale ▪ Spectral Resolution ▪ Radiometric Resolution ▪ Temporal Resolution ▪ Cameras and aerial photography ▪ Multispectral scanning (MSS) ▪ Thermal Imaging ▪ Geometric Destortion ▪ Weather satellites ▪ Land Observing Satellites ▪ Marine Observing Satellites ▪ Optical vs Radar Satellites ▪ Geostationary vs..... Satellites	2 days
Mod 3. Theory Microwaves	• Introduction • Viewing geometry and spatial resolution • Image distortion • Target interaction • Image properties • Advanced application • Polarimetry • Air borne vs. Space borne systems	1 day
Mod 4. Practical Image Analysis	• Introduction • Visual interpretation • Digital Processing • Pre-processing • Enhancement (Filtering, Georefernce, Mosaic etc) • Transformations • Classification (Unsupervised and supervised classification) • Integration	4 days
Mod 5. Practical Application	• Introduction • Meteorology ➢ Precipitation ➢ Temperature • Disaster and Risk Reduction ➢ Disaster prone areas mapping • Agriculture ➢ Crop type ➢ Crop monitoring	2 days

	• Forestry ➢ Species identification ➢ Burn areas mapping ➢ Land cover/ use • Geology ➢ Structural mapping ➢ Geological units • Hydrology ➢ Flood delineation ➢ Soil moisture • Cartography ➢ Planimetry ➢ DEMS ➢ Topographic mapping	

Table A 7b Training Modules on RS

					Exchange rate	171
Descrition	**Unit**	**Number of trainees**	**Day of training (refer days per Modules)**	**Unit Cost**	**Total cost in MWK**	**Total cost in USD**
Allowances / Per Diem°	MWK / Day	10	22	3.000	660.000	3.860
Rent of Education Centre	MWK / Day	1	22	68.400	1.504.800	8.800
Consultancy Fees*	MWK / Day	-	22	51.300	1.128.600	6.600
Transport Refund#	MWK / Day				-	-
Other associated cost	MWK / Day				-	-
Total Cost					**3.293.400**	**19.260**

° Figure to be provided by the Gov. Dep.

* Estimated > app. 300USD /Day

Depending on tranee duty station

Table A 7c Table to calculate cost of training

ANNEX 8 – Recommended purchases for the long term and short term interventions

Below we propose two different tables: the first for a comprehensive set of supplies necessary for the long term intervention proposed, the second represent the initial supply for the short term interventions (see chapter 4)

Please refer to the excel doc.

Table A 6.1 Long term recommended purchases

Please refer to the excel doc.

Table A 6.2 Short term recommended purchases

Annex 9 – Some information of the consultant team

The consultant team was composed by the following personnel (in alphabetical order by name):

Name	Postion / Organization	Role
Alexandre Castellano	Country director / COOPI	Team Leader / report writing
Michael Hagenlocher	GIS Expert / Z_GIS	GIS expert / data collection / analysis / report writing
Luca Galimberti	GIS Expert / COOPI	GIS expert / data collection / report writing
Memory Tchale	M&E Officer / COOPI	Facilitation and organization of filed operation / testing questionnaire
Stefan Kienberger	GIS / RS Expert / Z_GIS	GIS expert / data collection / analysis / report writing
Peter Zeil	Senior advisor / Z_GIS	Methodology advisor / report writing