

UN-SPIDER



UNITED NATIONS
Office for Outer Space Affairs

Technical Advisory Mission

Ghana

24-29 November 2013



UNITED NATIONS
Office for Outer Space Affairs

**United Nations Platform for Space-based
Information for Disaster Management and
Emergency Response
(UN-SPIDER)**



**Report of the
Technical Advisory Mission
To
Ghana**

24-29 November 2013

About UN-SPIDER

In its [resolution 61/110](#) of 14 December 2006, the United Nations General Assembly agreed to establish the "**United Nations Platform for Space-based Information for Disaster Management and Emergency Response - UN-SPIDER**" as a new United Nations programme, with the following mission statement: *"Ensure that all countries and international and regional organizations have access to and develop the capacity to use all types of space-based information to support the full disaster management cycle"*.

UN-SPIDER aims at providing **universal access** to all types of space-based information and services relevant to disaster management by being a **gateway** to space information for disaster management support; serving as a **bridge** to connect the disaster management and space communities; as well as being a **facilitator** of capacity building and institutional strengthening.

Whereas there have been a number of initiatives in recent years that have contributed to making space technologies available for humanitarian and emergency response, UN-SPIDER is the first to focus on the need to ensure access to and use of such solutions during all phases of the disaster management cycle, including the risk reduction phase, which will significantly contribute to reducing the loss of lives and property.

Acknowledgements

The United Nations Office for Outer Space Affairs is grateful to **Mr. Kofi Portuphy**, National Coordinator of the National Disaster Management Organization (NADMO), for extending an invitation to the UN-SPIDER Technical Advisory Mission (TAM) to Ghana and for providing support to the team during the mission. Our special thanks go to **Mr. Yao Kiatchey** and **Mr. Abrokwa Koranteng** (NADMO) for working closely with our Office and bringing together the mission programme as well as for the ongoing support and help during the week of the mission.

Contributions from the following mission members are acknowledged: **Ms. Natassa Antoniou** (Secure World Foundation, Brussels), **Dr. Caroline Bain** (MetOffice, UK), **Mr. Coen Bussink** (Head of Mission, Office for Outer Space Affairs), **Dr. Godstime James** (National Space Research and Development Agency, Nigeria), **Dr. Andries Jordaan** (University of Free State, South Africa), **Ms. Longfei Liu** (Office for Outer Space Affairs, Beijing), **Dr. Jörg Szarzynski** (United Nations University, Bonn), **Ms. Wang Wei** (National Disaster Reduction Center China / NDRCC), **Mr. Markus Woltran** (Office for Outer Space Affairs), **Dr. Zinta Zommers** (UNEP Kenya).

The mission team is thankful to the heads of institutions visited during the mission. The mission team would like to thank all individuals and institutions that participated in the workshop and stakeholder meetings organized during the mission. In addition, the Mission Team would like to acknowledge the support provided by Gregor Qualitz, who kindly assisted in the editing of the report.

The boundaries, names and designations used in this report do not imply official endorsement or acceptance by the United Nations.

This report has not been formally edited.

Abbreviations

AAP	Africa Adaptation Programme	JST	Japan Science and Technology Agency
AEP	Annual Exceedance Probability	KAIPTC	Kofi Annan International Peacekeeping Training Centre
CCA	Climate Change Adaption	KNUST	Kwame Nkrumah University of Science and Technology
CERSGIS	Centre for Remote Sensing and Geographic Information Services	NADMO	National Disaster Management Organization
CREW	Community Resilience through Early Warning	NAFGIM	National Framework for Geospatial Information Management
CSIR	Soil Research Institute	NDPC	National Development Planning Commission
DEM	Digital Elevation Model	NDMP	National Disaster Management Plan
DM	Disaster Management	NDRRC	National Disaster Reduction Center China
DRM	Disaster Risk Management	NOAA	US National Oceanic and Atmospheric Administration
DRR	Disaster Risk Reduction	NSDI	National Spatial Data Infrastructure
ECOWAS	Economic Community of West African States	NSOP	National Standard Operating Procedures
EOC	Emergency Operation Centre	RECTAS	Regional Centre for Training in Aerospace Surveys in Nigeria
EPA	Environmental Protection Agency	RS	Remote Sensing
EWS	Early Warning System	SATREPS	Science and Technology Research Partnership for Sustainable Development
FAO	Food and Agriculture Organization	SDI	Spatial Data Infrastructure
FC	Forestry Commission	SKA	Square Kilometre Array
FEMA	US Federal Emergency Management Agency	SMD	Survey and Mapping Division
GEM	Ghana Environmental Management Project	TAM	Technical Advisory Mission
GFDRR	Global Facility for Disaster Reduction and Recovery	TCPD	Town and Country Planning Department
GIS	Geographic Information System	UN-CECAR	University Network for Climate and Ecosystems Change Adaption Research
GIZ	German Society for International Cooperation	UNDP	United Nations Development Programme
GMet / GMA	Ghana Meteorological Agency	UNEP	United Nations Environmental Programme
GNFS	Ghana National Fire and Rescue Service	UNFCCC	United Nations Framework Convention on Climate Change
GoG	Government of Ghana	UNICEF	United Nations Children Fund
GSD	Geological Survey Department	UNOOSA	United Nations Office for Outer Space Affairs
GSS	Ghana Statistical Service	UN-SPIDER	United Nations Platform for Space-based Information for Disaster Management and
GSSTI	Ghana Space Science and Technology Institute	UNU-EHS	United Nations University Institute for Environment and Human Security
HFA	Hyogo Framework for Action	UNU-INRA	United Nations University Institute for Natural Resources in Africa
HSD	Hydrological Services Department	VHR	Very High Resolution
ICP	Incident Command Posts	VRA	Volta River Authority
IIPACC	Innovative Insurance Product for Adaptation to Climate Change	WFP	World Food Programme
IPCC	Intergovernmental Panel on Climate Change	WRC	Water Resources Commission
JICA	Japan International Cooperation Agency	WRI	World Risk Index

Table of contents

Acknowledgements	4
Abbreviations	5
Table of contents	6
1. Introduction	9
2. Objectives of the mission	11
3. Hazards and disasters in Ghana	13
3.1 Statistics at a glance – Global level assessments	13
3.2 Statistics at a glance – Country level data	13
3.3 Institutional context of Disaster Risk Management (DRM) in Ghana	15
4. Observations of the mission team	18
4.1 Mission activities at a glance	18
4.2 Status of use of geographic and space-based information in institutions involved in disaster risk reduction and emergency response in Ghana	20
5. Assessment by the mission team	35
5.1 Policy and Coordination	35
5.2 Data and access/availability	37
5.3 Capacity Building and Institutional Strengthening	39
5.4 Communication/ navigation technology	40
6. Recommendations	42
6.1 Policy and Coordination	42
6.2 Data and Access	43
6.3 Information management	44
6.4 Capacity Building and Institutional Strengthening	45
6.5 Communication/navigation technology	47
7. Next steps	47
ANNEX I Mission schedule	48
ANNEX II Short description of the visits	49
ANNEX III Geospatial data in policy documents on DRR	53
ANNEX IV Workshop Registration List	59
ANNEX V Bibliography	61

Executive Summary

Upon the invitation of the Government of Ghana through its National Disaster Management Organization (NADMO), UN-SPIDER carried out a Technical Advisory Mission (TAM) to Ghana from 24 to 29 November 2013

UN-SPIDER invited a mission team comprising of ten experts drawn from various international organisations, research institutes and Universities. The key objectives of the TAM were to assess national capacity and to evaluate existing disaster management and disaster risk reduction activities, policies and plans with regard to the use of space-based technologies and to facilitate access of national institutions to space-based information to support tasks contemplated in the full cycle of disaster management

Meetings were held with key stakeholders within the government, associated departments/agencies and international organisations, donors and UN offices. In total, seventeen different institutions have been consulted. In addition, a one-day national workshop was conducted on 28th November 2013 which brought together 50 participants and stakeholders from the academia, ministries, departments, NGOs and international organisations. A wide variety of subjects were addressed including remote sensing applications for disaster risk management, the use of weather and climate information, institutional arrangements to be made, practices in the use of space-based technology in other countries and the need to access existing international mechanisms that make satellite information available to support disaster preparedness and emergency response.

The assessments and recommendations put forward by experts are discussed in detail in Sections 4, 5 and 6. These sections provide critical inputs to all stakeholders of NADMO involved during the Mission. While detailed recommendations are discussed in section 6, the key recommendations are summarised below:

- a. Policy and Coordination: Disaster Management Plan needs to be upgraded to incorporate space-based information, clear roles for the different agencies need to be defined and the access to geospatial data needs to be facilitated
- b. Data and Access: NADMO should be registered as an Authorised User to the International Charter and linked to other international mechanisms. The data dissemination within the Ghana Government and to non-governmental organisations needs to be further reviewed
- c. Information management: A permanent Geographical Information unit with 24/7 alertness capacity needs to be established, GPS equipment for response service is necessary and knowledge of open source GIS software needs to be strengthened
- d. Capacity Building and Institutional Strengthening: Training capacities within the country (e.g. universities) should be used, as well as the capacities of the UN-SPIDER Regional Support Office and others like FEMA.

- e. Communication/navigation technology: Apart from NADMO, more agencies should receive technology for satellite-based positioning and communication.

This report submitted to the National Disaster Management Organization and stakeholder organisations will help support the development of the National Action Plan and help secure dedicated resources for applications of space-based/geospatial information to develop disaster management plans.

1. Introduction

The United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER) was established by the United Nations General Assembly in 2006 with the following mission statement:

"Ensure that all countries and international and regional organizations have access to and develop the capacity to use all types of space-based information to support the full disaster management cycle".

The National Disaster Management Organization (NADMO) invited UN-SPIDER to expand and strengthen the capacity and awareness of different institutions in Ghana to integrate and apply spatial and space-based information within their decision making processes.

One of the core activities of the UN-SPIDER programme is to provide technical advisory support to countries, including carrying out Technical Advisory Missions (TAM) to meet with key disaster management authorities in the Government, United Nations agencies, regional and international organisations/initiatives and private entrepreneurs to discuss the topic in depth and make recommendations to improve the use of space-based information in disaster management.

The mission team comprised experts representing different specialised entities from various countries, representatives of research centres, intergovernmental organisations, UN and other international organisations which are either engaged with Ghana in this area or have a certain expertise in a specific field of knowledge relevant to the specific context of Ghana and its region. The mission team met key stakeholders and policy makers dealing with disaster management and/or geospatial technologies.

The team that conducted the UN-SPIDER Technical Advisory Mission to Ghana from 24th November 2013 – 29th November 2013 included 10 experts from the following organisations:

- **Ms. Natassa Antoniou**, Secure World Foundation, Brussels |
- **Ms. Caroline Bain**, MetOffice, United Kingdom |
- **Mr. Coen Bussink**, United Nations Office for Outer Space Affairs, Head of Mission |
- **Mr. Godstime James**, National Space Research and Development Agency, Nigeria |
- **Mr. Andries Jordaan**, University of Free State, South Africa |
- **Ms. Longfei Liu**, United Nations Office for Outer Space Affairs, Beijing office |
- **Mr. Jörg Szarzynski**, United Nations University, Germany |
- **Ms. Wang Wei**, National Disaster Reduction Center of China (NDRCC) |
- **Mr. Markus Woltran**, United Nations Office for Outer Space Affairs |
- **Ms. Zinta Zommers** (United Nations Environment Programme, Kenya).

Thus, the team offered a wide range of expertise and in-depth knowledge covering areas such as disaster management, geospatial technologies, crowdsourcing, current trends in space technologies, policy and legal framework, and issues in developing countries in Africa related to capacity building, information management and disaster management planning and policies.

UN-SPIDER Technical Advisory Support

Technical Advisory Support (TAS) is one of the prime activities of the UN-SPIDER programme at the national level. It serves to identify the existing capacity to use space-based information, analyzing the institutional framework to support disaster management through space-based information and identifying the limitations. TAS attempts to enable a particular government to overcome current limitations regarding the use of space-based information for disaster management. It also deals with international cooperation and regional opportunities, networking with regional institutions and setting up disaster management plans. It covers region-specific aspects such as trans-boundary issues, emergency response, risk assessment, GIS-based disaster management systems and disaster risk reduction.

Technical Advisory Support could range from a simple consultative phone call to full-fledged in-situ technical support. It often materializes in any of the following three forms:

- Technical Advisory Missions involving experts from various space and disaster management agencies and countries under the umbrella of one mission.
- Technical advice to national institutions by means of meetings, teleconferences, video conferences etc.
- Facilitating direct cooperation between national institutions and satellite imagery providers

Technical Advisory Missions have to be requested by the respective national government.

They typically generate:

- Reports with recommendations and follow-up actions
- Guidelines/policies on disaster management issues, emphasizing the use of space-based information in all stages of disaster management
- Facilitation for capacity building in collaboration with UN-SPIDER and partner organisations
- Partnership for developing emergency support mechanism

2. Objectives of the mission

The activities carried out during the mission aimed at:

- a) Assessing national capacity and evaluating disaster management and disaster risk reduction activities, policies and plans with regard to the use of space-based technologies.
- b) Assisting in the definition of risk and disaster management plans and policies with regard to the use of space-based technologies.
- c) Developing and customizing guidelines and templates for including space-based technologies into disaster risk reduction and emergency response.
- d) Facilitating access of national institutions to space-based information to support disaster risk reduction and emergency response activities.
- e) Identifying training needs and facilitating the implementation of capacity building activities.
- f) Supporting the implementation of risk reduction and emergency response activities using space-based technologies.

It was expected that this technical advisory mission would help NADMO to:

- Link national disaster management authorities with the geospatial community within the country/region
- Promote data sharing (with focus on geospatial data, more specifically space-based information) within institutions to benefit the disaster management community
- Contribute to the disaster management plans and policies to help emphasize the use of space-based information in all stages of disaster management
- Provide opportunities to the country to access satellite-based information and solutions during emergency response
- Offer the opportunity to strengthen participation in existing networks and the various Virtual and Technical Communities (V&TCs).

The overall objectives are presented below. The outputs were derived through participatory approach involving the team of experts and departments/organisations within Ghana. One important output to be gained during the TAM was the raising of awareness among end-users of the existing opportunities available for accessing space-based information to support disaster risk management activities, including through UN-SPIDER. Expected outcomes were defined in the recommendations brought together and implemented with the support of identified stakeholders.

Table 2.1. Objectives and expected outcomes of a UN-SPIDER TAM

Objectives	Output	Expected Outcomes
Review current policies, procedures and mechanisms related to the use of geo-spatial information and make recommendations.	Policy level recommendations for effective usage of geo-spatial information for disaster risk management.	Disaster risk reduction and emergency response is strengthened through an efficient and effective usage of space-based information and technologies.
To engage key stakeholders who are custodians of geo-spatial data relevant to disaster risk management	Identify inter-institutional strategies and mechanisms for improved coordination among data providers and data users to boost information sharing amongst the stakeholders	Geo-spatial information is available for disaster risk management and emergency response and recovery on a timely basis and with higher interoperability.
Develop an institutional strengthening strategy for stakeholder agencies (individuals, institutions and infrastructure)	Policy-relevant recommendations on a medium and long-term institutional strengthening plan and possible funding sources to be identified.	Top level decision makers are aware of technology trends, best practices and needs. More trained personnel capable to utilize space-based technologies for disaster management.
Develop a long-term association with UN-SPIDER to take advantage of outreach activities, institutional strengthening programmes and resources available through the UN-SPIDER network.	Understand the best approach to establishing a national forum to communicate with the stake holders and develop action plan to implement recommendations.	Efficient uses of national capacity and resources available through UN-SPIDER network during emergency situations, as well as in non-emergency situation.

3. Hazards and disasters in Ghana

3.1 Statistics at a glance – Global level assessments

The World Risk Index (WRI)¹ developed by the United Nations University Institute for Environment and Human Security (UNU-EHS) ranks Ghana according to its report for 2012 on rank 45. This is due to relative high levels in vulnerability including susceptibility, lack of coping capacities as well as a lack of adaptive capacities. Exposure values – in this sense refers to entities (population, built-up area, infrastructure component, environmental areas) being exposed to the effects of one or more natural hazards (earthquakes, cyclones, droughts and floods) – are characterized by relative low values. Vulnerability itself is characterized by the susceptibility, lack of coping capacities and the lack of adaptive capacities, whereas highest values have been identified for the lack of coping capacities. Coping capacities comprise various abilities of societies to minimise negative impacts of natural hazards and climate change through direct action and the resources available. Coping capacities encompass measures and abilities that are immediately available to reduce harm and damages in the occurrence of an event. The WRI is a global assessment and compares different countries based on globally available datasets. Therefore the ranking has to be seen within this comparative context and is limited to a single country assessment.

Rank	Country	WorldRiskIndex	Exposure	Vulnerability	Susceptibility	Lack of coping capacities	Lack of adaptive capacities
41.	Burkina Faso	9.74 %	14.32 %	68.00 %	54.81 %	84.86 %	64.32 %
42.	Burma	9.15 %	14.87 %	61.57 %	36.70 %	89.82 %	58.18 %
43.	Mozambique	9.09 %	12.73 %	71.37 %	67.63 %	84.91 %	61.58 %
44.	Côte d'Ivoire	9.00 %	13.67 %	65.84 %	47.34 %	88.55 %	61.64 %
45.	Ghana	8.85 %	14.48 %	61.12 %	47.12 %	79.06 %	57.16 %
46.	Mali	8.76 %	12.55 %	69.76 %	56.57 %	82.87 %	69.85 %
47.	Uzbekistan	8.71 %	16.18 %	53.84 %	32.33 %	77.85 %	51.35 %
48.	Suriname	8.62 %	18.12 %	47.60 %	30.01 %	73.27 %	39.53 %
49.	Guinea	8.55 %	12.03 %	71.05 %	58.08 %	90.16 %	64.91 %
50.	Kyrgyzstan	8.50 %	16.63 %	51.10 %	27.54 %	77.79 %	47.98 %

Excerpt from the UNU-EHS World Risk Report (<http://www.ehs.unu.edu/file/get/10487.pdf>)

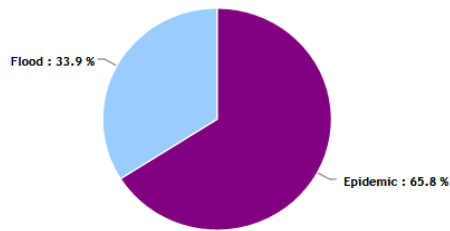
3.2 Statistics at a glance – Country level data²

Ghana ranks high amongst African countries most exposed to risks from multiple weather-related hazards. The country is exposed to floods and droughts, particularly in the Northern Savannah belt. The catastrophic floods in the North in 2007 affected more than 325,000 people with close to 100,000 requiring assistance in some form or another to restore livelihoods. The 2007 floods followed immediately after a period of drought that damaged

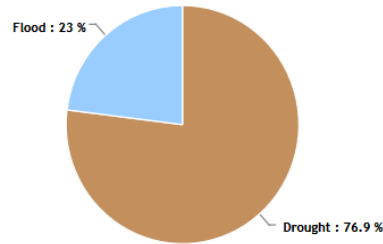
¹ UNU-EHS WorldRiskReport (<http://www.ehs.unu.edu/file/get/10487.pdf>)

² Disaster risk management programs for priority countries AFRICA (<http://gfdrr.org/ctrydrmmnotes/Ghana.pdf>)

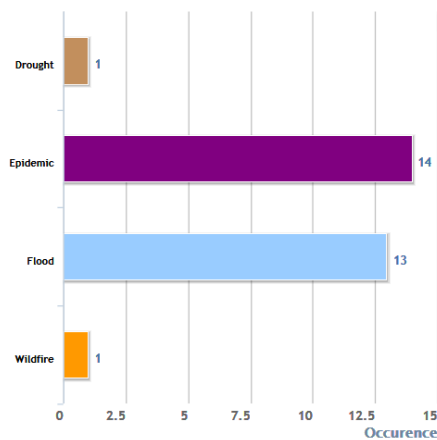
the initial maize harvest which were indicative of the high variability in precipitation and hydrological flows in Northern Ghana.



Percentage of reported people killed by disaster type (PreventionWeb)



Percentage of reported people affected by disaster type (PreventionWeb)

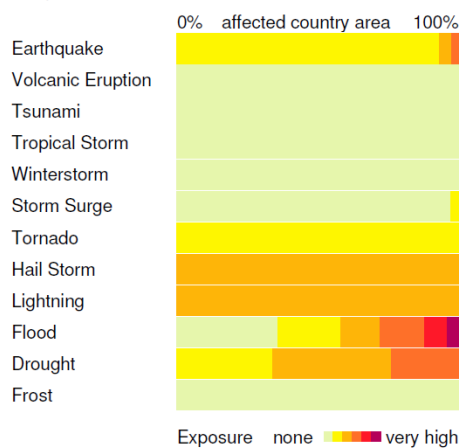


Natural Disaster Occurrence Reported (PreventionWeb)

Disaster	Date	Affected (no. of people)
Drought	1983	12,500,000
Flood	1991	2,000,000
Flood	1995	700,000
Flood	2007	332,600
Flood	1999	324,602
Flood	2001	144,025
Flood	2009	139,790
Flood	2008	58,000
Flood	2009	19,755
Flood	2010	9,674

Top 10 Natural Disasters Reported - Affected People (PreventionWeb)

Natural Hazards



Exposure
The bar charts show the degree of exposure to natural hazards and the percentage of area affected (per country).

Notes
Tsunamis and storm surges are a threat to coastal regions, particularly gulfs, bays, and estuaries. The flood hazard results from river floods and torrential rain. The hazard of dryness and drought is caused by major deviations from the normal amounts of precipitation.

Source: Munich Re Geo Risks Research, Last update: 10/12/2006

Degree of exposure to natural hazards and the percentage of the area affected in Ghana. (Munich Re Geo Risk Research).

Top 10 Natural Disasters in Ghana
for the period 1900 to 2014
sorted by numbers of total affected people:

Disaster	Date	No Total Affected
Drought	Oct-1983	12,500,000
Flood	14-Jul-1991	2,000,000
Flood	5-Jul-1995	700,000
Flood	10-Aug-2007	332,600
Flood	Sep-1999	324,602
Flood	27-Jun-2001	144,025
Flood	17-Sep-2009	139,790
Flood	26-Oct-2011	81,473
Flood	Jul-2008	58,000
Flood	Jul-1968	25,000

Top 10 natural disasters in Ghana (1900-2014) by numbers of affected people (EM-DAT)

Based on observed trends and future scenarios, climate change will increase extreme weather patterns and therefore exposing people to higher rainfall variability, water stress, drop in agricultural yields and depletion of resource-based livelihoods. Most likely, this will also increase the risk of drought periods, evapotranspiration and reduce agricultural productivity (10% lower rainfall is expected by 2050; IPCC 1997). Moreover, climate change will probably result in rising temperatures (1.4-1.6 higher temperature is expected by 2050; IPCC 1997), potentially increasing the risk of forest and bushfires.

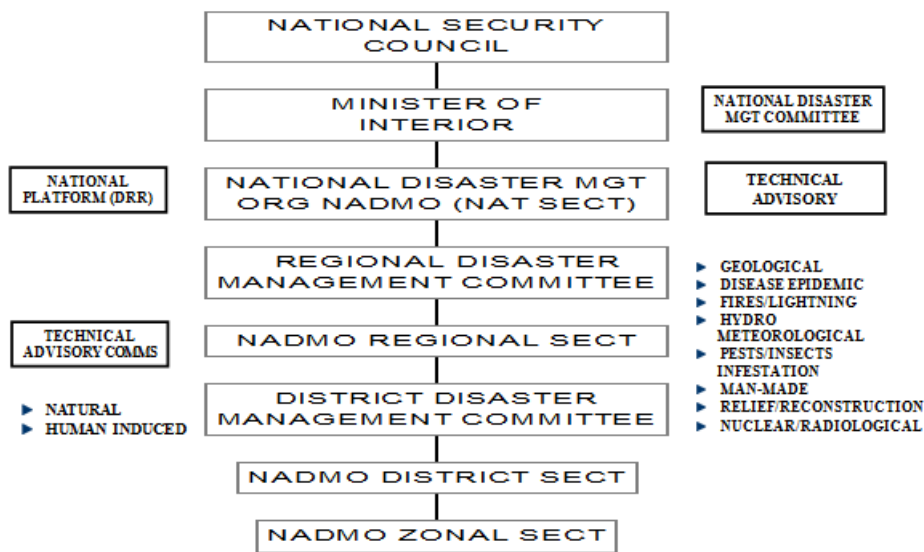
3.3 Institutional context of Disaster Risk Management (DRM) in Ghana

NADMO³ was established in 1996 with the mandate to coordinate disaster management activities in Ghana. NADMO operates under the Ministry of the Interior which enables it to coordinate all the relevant civil authorities at the national, regional and district levels. NADMO’s institutional framework consists of a National secretariat, ten (10) Regional secretariats, two hundred and forty-three (243) Metropolitan, Municipal and District secretariats and over nine hundred (900) Zonal offices throughout the country (see the figure below).

It aims to manage disasters by coordinating the resources of government institutions and non-governmental agencies, and developing the capacity of communities to respond effectively to disasters and improve their livelihood through social mobilization, employment generation and poverty reduction projects.

³ Source: <http://www.nadmo.gov.gh>

CHAIN OF COMMAND/CHANNEL OF COMMUNICATION
NATIONAL DISASTER MANAGEMENT



Chain of command/channel of communication for national disaster management

About 85% of NADMO’s resources and efforts are used for addressing issues related to hydro-meteorological disasters. Ghana is signatory to a number of global agreements on climate change and disasters; for example, the United Nations Framework Convention on Climate Change (UNFCCC) and the Hyogo Framework for Action (HFA), 2005-2015.

Other key government agencies involved at the national, regional and district levels for floods and droughts are illustrated in the simplified diagram below. *Ghana Meteorological Agency (GMet or GMA)* collects climate and weather data on a daily basis as well as prepares weekly and seasonal forecasting. The *Hydrological Services Department (HSD)* under the Ministry of Works and Housing is looking to develop further analysis of hydrological data regarding disaster impacts. For floods, the *Water Resources Commission (WRC)*⁴ may provide expert insights. For droughts, the *Ministry of Food and Agriculture* plays a significant role through providing technical assistance to farmers at the district and community levels through their agricultural extension services. In the case of large disaster events with a significant need for relief work, the *Ghana Armed Forces* provide support in

⁴ WRC is an organisation established in 1996 by Act 522 of 1996 with the mandate to regulate and manage Ghana's Water Resources and co-ordinate government policies in relation to them (Source, <http://wrc-gh.org/en/>).

the immediate relief and recovery processes in collaboration with NADMO, particularly during and after flood events.

Another key group of stakeholders in Ghana for Disaster Risk Reduction (DRR) are the international and bilateral development agencies. Various United Nations Agencies including the Food and Agriculture Organization (FAO), International Organization for Migration (IOM), United Nations Development Programme (UNDP), United Nations Children Fund (UNICEF), UNU Institute for Natural Resources in Africa (UNU-INRA) and the World Food Programme (WFP) are supporting the Government of Ghana to implement DRR projects as well as develop policies for DRR, as DRR is one of the key outcomes within the United Nations Development Assistance Framework for 2012 – 2016 (UNDP Ghana, 2011).

The World Bank Group has worked on DRR in Ghana as the Global Facility for Disaster Reduction and Recovery (GFDRR) has selected Ghana as one of their priority countries. They have supported the Water Resources Commission to implement hazard mapping activities along the White Volta (White Volta Flood Hazard Assessment and Forecasting project, 2008 – 2012), as well as conduct a review of flood emergency in Northern Ghana in 2008 (GFDRR, 2012). Specific flood models were built for the White Volta for that purpose, as part of that project.

The Japan International Cooperation Agency (JICA) in collaboration with UNU-INRA has embarked on a five-year research partnership with University of Ghana and GMet to conduct disaster risk reduction and climate change adaptation studies and projects in northern Ghana (JST, 2011).

The German Society for International Cooperation (GIZ) is conducting a project entitled, “Adapting Ghana’s agricultural ecosystems to climate change.” Through this effort, they are supporting the National Insurance Commission of Ghana to establish an innovative insurance product for adaptation to climate change (IIPACC). As part of IIPACC, weather information systems will be enhanced through upgrading of weather station networks and the use of satellite weather data (GIZ, 2012).

4. Observations of the mission team

4.1 Mission activities at a glance

The mission team spent 5 days in Ghana from 25th to 29th November 2013, arriving on the 24th of November. Prior to the mission, UN-SPIDER has had close interactions with NADMO, the governmental counterpart, to develop the logistical and technical aspects of the advisory mission, which was agreed upon through terms of reference. NADMO identified all potential institutions in Ghana that could be of interest for the purpose of the mission, after which UN-SPIDER made a sub-selection, which NADMO used to make the appointments during the mission week. During the mission, some adjustments were made to the agenda and additional institutions were identified as important to be visited. Before the mission, a country profile was compiled by NADMO and UN-SPIDER to provide the advisory team insights into the framework and background of disaster management in the country and the current use of space-based information for risk and disaster management.

The TAM team visited a total of 17 agencies and institutions discussing their role in disaster management and the use of space-based information, geo-spatial technology and information in general for disaster management. On the first day, the team visited the organisations as one group but then split into two groups for the 2nd and 3rd day so that more agencies could be visited within the limited time frame. The institutions visited are listed in Table 4.1. A one-day workshop was organised on the fourth day (28 November) of the TAM with 50 participants from several agencies and institutions that are active in disaster management, emergency response and/or geo-information in Ghana.

At the end of each day of the mission week, the TAM team compiled the observations and discussed the findings of the day. On the last day, the TAM team prepared a high level debriefing meeting to the Government of Ghana, represented by the coordinator of NADMO, staff from NADMO and several national media. See for short description of the visit annex II.

Table 4.1. The institutions visited during the UN-SPIDER TAM

National Disaster Management Organization (NADMO)	Ghana Atomic Energy Commission (GAEC) Ghana Space Science & Technology Institute (GSSTI)
United Nations Development Programme (UNDP)	Hydrological Services Department (HSD)
Survey and Mapping Division (SMD)	Ghana National Fire Service (GNFS)
Department of Geography and Resource Development of the University of Ghana	Geological Survey Department (GSD)
Ministry of Food and Agriculture (MoFA)	Environmental Protection Agency (EPA)
Centre for Remote Sensing and Geographic Information Services (CERSGIS)	Ghana Statistical Service (GSS)
Town and Country Planning Department (TCPD)	Ghana Ports & Harbour Authority (GPHA)
The Forestry Commission (FC)	Kofi Annan International Peacekeeping Training Centre (KA IPTC)
Ghana Meteorological Agency (GMet)	



TAM team members with on the right Mr. Yao Kiatchey (Assistant Chief Director) at the NADMO premises.

4.2 Status of use of geographic and space-based information in institutions involved in disaster risk reduction and emergency response in Ghana

4.2.1 National Disaster Management Organization (NADMO)

Role in Disaster Management

NADMO is part of the Ministry of Interior and has the mandate to coordinate disaster response activities at the national, regional and district levels, for which NADMO has offices at each level. The organisation was established in 1996 through Act 517 and is governed by the National Security Council. Its mandate includes the drawing of plans to prevent disasters or mitigate their effects on residents in Ghana, to coordinate activities before and during emergencies as well as ensuring post disaster rehabilitation, resettlement and reconstruction (NDPM 2010). NADMO is divided into departments covering thematic issues and each department leads a technical committee where relevant organisations are represented and which guarantees interaction between ministries/agencies. A National Platform for Disaster Risk Reduction is the overarching framework led by the coordinator of NADMO and meets once a year. Recently a national Emergency Operation Centre (EOC) was created, which will be operational in a new building at the NADMO premises. The Emergency Operations Centre (EOC) gets support from the United States Africa Command (250,000 USD), World Bank (500,000 USD), National Guard of North Dakota and other UN Agencies and with emergency operating lines provided by the Telephone Companies (National Platform Report 2013). There have been projects on risk information systems in the past where NADMO was not part of (Red Cross, World Vision) and with different names (e.g. Risk Information System, National Risk Observatory). Currently, NADMO is cooperating with UNDP in a project called Community Resilience through Early Warning (CREW) which has pilot projects in 10 (out of 206) districts. The goals of the project is to build capacities within the country to reduce disaster risk by putting in place an integrated early warning system that is both scientific and people-centred. The outcomes of the project will be used by NADMO to build a National Risk Observatory that will monitor the evolution of hazards and issue appropriate warning to at-risk population.

Use of space and geospatial technologies

The use of GIS (Geographic Information Systems) and space-based information for disaster management is at its inception stage. Two GIS staff members were trained by the US Federal Emergency Management Agency (FEMA)/North Dakota in a two week course on geographic information systems for emergency with modelling and risk assessment exercises in ESRI ArcGIS. The use of geographic information will be part of the National Emergency Operation Centre, which foresees to use the web for exchanging information. Nevertheless, NADMO currently does not have GIS licenses. The USA is financially supporting the Centre. NADMO

has very good communication technology in the form of VHF radio communication equipment. Extensive risk mapping has been carried out in certain areas of Ghana (e.g. the White Volta Basin supported by the World Bank, hazard mapping in five pilot districts under the African Adaptation Project by NADMO, USAID's Ghana's Climate Change and Vulnerability Assessment, WFP's Comprehensive Food Security and Vulnerability Analysis (Source: UNDP).

Data/Information Sharing

The official set-up of NADMO is to be an open institution that shares its information without commercialising it. However, NADMO lacks the knowledge of what kind of data is available but sees the hierarchical structure as beneficial for getting data from HQ to the lower levels and vice versa. GSM, radio/media and fax are used to communicate information to the districts. While hazard maps are already available for selected districts in the country, the fast changing nature of population dynamics, coupled with the changes in the manifestation of climatic and hydro-meteorological hazards due to climate change, are not yet fully captured in these maps. In addition, there is no system for a continuous hazard risk monitoring. Available maps are static and there is no strategy for updating them on a regular basis.

Constraints and challenges

Currently, NADMO does not have any geographic data yet and also the capacity to work with the data has just started. There is no data policy and strategy in place and there is no awareness of mechanisms for getting satellite data or coordination with other institutions to get geographic data. The communication line to the districts seem to be good, however, information flow from districts to national level is a challenge. NADMO's presence at the local level through its officers and community volunteers is not yet leveraged in disseminating early warning information.

4.2.2 United Nations Development Programme (UNDP)

Role in Disaster Management

UNDP supports disaster management projects in all stages of the disaster cycle, including policy development. UNDP has worked closely with the Government of Ghana (GoG) in providing technical and financial support in this area. UNDP has assisted the National Disaster Management Organization (NADMO) in designing a multi-sectoral integrated Plan of Action for Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) 2011 – 2015 in achieving Ghana's commitments under the Hyogo Framework for Action (HFA). Building on this partnership, UNDP is continuing to work with GoG to implement various DRR and CCA initiatives as well as supporting them to mobilize funds to take the plan into action.

Until recently, more emphasis was paid to response, rather than prevention and preparedness. The ambition of the Ghana Action Plan for Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) is to foster a transition from reactive (baseline) to a more anticipatory and systematic disaster risk management in the country. In 2012, UNDP started a project on early warning called Community Resilience through Early Warning (CREW). Parts of the project are disaster risk assessments to be made at the national level and in 10 pilot sites. The project will last until 2015.

Use of space and geospatial technologies

The UNDP is not directly involved in the collection or use of satellite imagery. However, the programme has a GIS expert who is leading the CREW project. The risk assessment part of the project is currently in the process to be outsourced to an international consultant and foresees in the collection of historical data, including satellite imagery, hazard maps. The major outcomes will include a risk database and GIS-based disaster vulnerability maps and interactive web-maps. Primary stakeholders are: Water Resources Commission (WRC), National Disaster Management Organization (NADMO), Ghana Meteorological Agency (GMet), Hydrological Services Department (HSD), Volta River Authority (VRA), Universities/research institutions.

Data/Information Sharing

At the UNDP premises, a database is maintained by the UN interagency country team which contains information on agencies in the country and the projects that are ongoing. UNDP works with the Ghana Statistical Service in getting data on population and socio-economics. UNDP identifies data sharing between organisations as a big constraint. Available information is scattered and legal policy on data sharing or an integrating platform are lacking. UNDP sees that disaster information from the districts to NADMO HQ is hampered and could be improved e.g. by using the disaster volunteer groups. UNDP mentions the existence of a humanitarian working group, which becomes active after a disaster and through which data is exchanged.

Constraints and challenges

According to UNDP, NADMO has visibility and is recognized for its coordinating and neutral role in disaster management. However, the contribution of the sector ministries could be strengthened and formalized. The office of the Vice President could play an integrating role. NADMO should have the capacity to coordinate data integration. The UN action plans (5 years) could be used to strengthen the role of space-based information and include recommendations from this Technical Advisory Mission. The National Development Planning Commission (NDPC) could be the forum to guarantee coordinated action and data exchange for disaster management.

4.2.3 Survey and Mapping Division (SMD)

Role in Disaster Management

The Survey and Mapping Division is the government agency (Ministry of Lands and Natural Resources) that takes care of producing primary data and produces base maps products: topographic maps, cadastral, roads, political boundaries and thematic maps. The Division claims to be the main responsible office/institution for any kind of map. However, there is evidence that it is sometimes bypassed, for example, it was not involved in the 2007 and 2011 flood mapping. The Division has regional offices in 10 regions. Maps are available at 1:2500 for towns. The Division has the following sections: Examination section, Cartographic and digital mapping section, Printing and lithographic section, Photogrammetric section and it has about 120 staff at HQ and 10 to 15 staff in each region, of which most of them are field surveyors. One staff from NADMO was trained at the Division.

Use of space and geospatial technologies

Mapping is done exclusively with aerial photos, with very little satellite imagery. It was stated that this is because of the required details and accuracy needed. Aerial photos are taken by private (foreign) companies and new images are currently being acquired for the South of Ghana. The Division uses ArcGIS (3 licenses) and Webmap-publisher and Adobe Illustrator for creating maps. The service has Trimble and Strato GPS. In the past, the Division had received trainings from ITC (University of Twente, Netherlands). It claims that on one hand, there was no need for any further training on GIS; however, on the other hand, the division lacks access and capacity to use satellite imagery as well as processing capacity. The division sees itself playing a major role in developing a National Spatial Data Infrastructure (NSDI).

Data/Information Sharing

The Division sells hardcopy maps and digital data is restricted and made available to selected government agencies.

Constraints and challenges

Although the mandate of the Division should ensure it plays a key role in any geographic data projects, it has few direct linkages and working cooperation with other ministries. The geographic data is strongly protected and there is lack of a policy for data sharing. The division says it lacks computers, GPS, work force and other resources.

4.2.4 Department of Geography and Resource Development of the University of Ghana

Role in Disaster Management

The focus of the research agenda in the department is on climate change, desertification, urban planning, flooding in urban areas and land degradation. It also has worked on fire mapping with VHR satellite imagery in Accra and Kumasi. The Department has an agreement with the Fire Service for mapping fire risks and conducts training of police and immigration.

Use of space and geospatial technologies

There are 6 professionals working with GIS and RS, the department has two computer laboratories for 65 persons in total. The software used in the laboratories include: ArcGIS, ENVI and QGIS. There is a 20 Terabyte enterprise database. Currently, 200 undergraduate, 20 MSc and 6 PhD students are taking GIS/RS courses. The Department has limited access to satellite imagery, uses Landsat and VHR images for small areas, and has no experience with Radar imagery.

Data/Information Sharing

The Department has an initial agreement with NADMO to cooperate on data sharing, training and technical support; however, a training that was recently offered free of charge was not attended by NADMO. Staff of the Department participated in the FEMA training (see NADMO section) and with this knowledge it is now collecting disaster data. The enterprise database is meant to give access to data for various institutions like Police, Statistical Service, Forestry Commission, Fire Service and Immigration Service. Access to the data is tailored for each user, depending on the agreement. There is little cooperation with the direct neighbour that works with geospatial data: CERGIS.

Constraints and challenges

The Department has considerable technological capacity, has moderate level of knowhow and potential for extension but is not involved in major projects, e.g. the CREW project (see UNDP) and the JICA/CECAR project, see annex III.

4.2.5 Ministry of Food and Agriculture (MoFA)

Role in Disaster Management

The Ministry has close contact with NADMO and provides information on agricultural-related disasters and threats, e.g. insects/pest invasions. The major disaster topics for the Ministry are pests, droughts and floods; it depends on information from the meteorological services for drought monitoring. Crop yields are assessed with ground information. There is

an eAgriculture website (Ghana Agricultural GIS online Platform, <http://www.gis4ghagric.net/>) which provides geographic and statistical data on crop, soils, climate and land use; this concept could be used for DRR and early warning (see CERSGIS). The extension services could use these data, however it is not operational yet. Another pilot project is testing insurance for farmers by using weather indices and interpolated satellite rain data (using NOAA imagery).

Use of space and geospatial technologies

The Ministry does not have a GIS unit. It gets maps from Cape Coast University, KNUST (Kwame Nkrumah University of Science and Technology), University of Ghana (Southern part of Ghana), Geological Survey and soil maps from the Soil Research Institute (CSIR). Some meteorological satellite data products are used (NOAA, TAMSAT). There is interest in new technologies, however, there is lack of understanding of the potential applications and does not have capacity to work with geospatial data. Already, some staff of the ministry has participated in the GIS workshop by FEMA (see NADMO).

Data/Information Sharing

The Ministry depends mainly on geospatial data provided by external entities. Until now, agricultural statistics are made available through the Statistical Service. Currently, the Ministry has started to provide data through an e-portal, however, this is at an initial stage.

Constraints and challenges

The Ministry recognises the potential to enhance preparedness for disasters with an early warning system for crop failures through weather forecasting; nevertheless, it does not have the capacity to develop this and it refers to NADMO to take the lead.

4.2.6 Centre for Remote Sensing and Geographic Information Services (CERSGIS)

Role in Disaster Management

CERSGIS does not have a formal working relationship with NADMO. However, it has cooperated with NADMO on an *ad-hoc* basis, e.g. it has provided NADMO with data on hydrology, digital elevation models (DEMs), forest reserves and settlements areas for the northern region, upper east and upper west due to the flood disasters. CERSGIS has provided some flood maps on request of the Government of Ghana. There are plans to assist NADMO with the development of the GIS centre.

Use of space and geospatial technologies

CERSGIS has the capacity to acquire and process satellite image data. It has worked on flood mapping, land use mapping, road mapping (GPS tracking) and participated in the development of the agricultural data provision through a webpage portal (<http://www.gis4ghagric.net>) and the agricultural insurance project (see ministry of Food/Agriculture) for which CERSGIS provided the GIS data. CERSGIS gives training sessions in the use of GIS/RS and spatial analysis. The services of CERSGIS are used by several organisations that were visited, including government agencies, UN organisations, private sector and universities. The services are provided on a “cost-recovery” basis. CERSGIS participated in the FEMA training (see NADMO) and it recently acquired the capacity to work with radar imagery. It has 18 technical staff.

Data/Information Sharing

CERSGIS has worked with various organisations. It purchases data, e.g. from the survey department. It has trained staff of the Statistical Service on spatial analysis. CERSGIS has no knowledge of the International Charter Space and Major Disasters or other satellite data mechanisms.

Constraints and challenges

Baseline data has to be purchased from the Survey Department, and it is provided in analogue form so it has to be transformed into digital formats. CERSGIS has technical capacity but lacks scientific knowledge of disaster management.

4.2.7 Town and Country Planning Department (TCPD)

Role in Disaster Management

The Town and Country Planning Department (TCPD) is responsible for urban spatial planning, including street naming, property assessment system and planning of roads.

The Department cooperates with NADMO for identifying flood prone areas and mitigation of disasters in the planning of cities. A map with flood-prone areas was developed after the 2009 floods (prepared by the Hydrological Services but was not updated since then). During the floods of 2011, the Department conducted a damage assessment. A new land use planning law is about to be approved by Parliament and will foresee in the implementation of GIS for integrated planning.

Use of space and geospatial technologies

Geospatial data is obtained from the survey department and spatial analysis was performed for some districts. There is a need for VHR satellite imagery which the Survey Department was not able to provide; TCPD then acquired some images themselves. Open source information like Google images are not detailed enough, since the TCPD needs to work at parcel level, e.g. for the street naming/numbering projects.

Data/Information Sharing

There has been good cooperation with relevant departments; however, the Department needs up-to-date and detailed data that the partners are not always able to provide.

Constraints and challenges

NADMO was part of a strategic planning committee in the past, this cooperation was discontinued and therefore challenges the cooperation. TCPD is open for including information on disaster-prone area but is dependent on the input and initiatives from relevant agencies.

4.2.8 The Forestry Commission (FC)

Role in Disaster Management

Relevant disasters for the Forestry Commission are wildfires and flooding. The FC is on the technical committee of NADMO and experts are provided depending on the nature of the disaster, e.g. in case of a bee invasion, the wildlife department was involved. In case of disasters, the district security committee reports to the regional office and then to the national office. The National Security Office directs which agencies should be involved in disaster management. FC is not aware of any contingency plan for disasters like wild fires and there is no fire risk rating system. Fire risks are assessed with common knowledge and FC does not see the need for involving meteorological data since the climatological seasons are clearly defined.

Use of space and geospatial technologies

The Forestry Commission has a RS/GIS center in Kumasi. The main topic where remote sensing is used is forest stock assessment, e.g. with aerial LIDAR imagery. Mapping fires is done in a subjective, non-systematic manner, sometimes applying GPS but without any remote sensing imagery. For geospatial services, the FC works together with CERSGIS.

Data/Information Sharing

Currently, Ghana (NADMO) lacks a central communication system in case of a disaster, which potentially hampers coordination in case of large fire incidents, which would require communication between FC, the Fire Service and NADMO.

Constraints and challenges

The FC does not see the need for technology-based early warning system and trust local knowledge; nevertheless agrees that effects of climate change would make this more pertinent. FC does see the need for fire detection and mapping of affected areas but lacks capacity for doing this in-house.

4.2.9 Ghana Meteorological Agency (GMet)

Role in Disaster Management

The Ghana Meteorological Agency (GMet) is responsible for monitoring and predicting weather and climate events in Ghana. GMet owns 22 synoptic stations across the country, 300 rain gauges and 50 Automatic Weather Stations; some of them are not active or are in a state of disrepair. If severe weather is predicted, GMet calls into radio stations and issues 'weather warnings', however, these are not graded by severity and are not assessed in terms of reliability or confidence and there are no guidelines on issuance or standard operating procedures in place. This means that warnings may have an inconsistent nature.

The agency uses statistical models for seasonal forecasting of the rainy season and provides this information directly to NADMO as well as the Ministry of Agriculture. The agency is a member of the Hydrometeorological Disasters technical committee of NADMO, however, there has not been any meeting this year (2013).

Use of space and geospatial technologies

The agency uses EUMETSAT data for weather forecasting and has one forecaster workstation in the whole country for receiving satellite data. Rainfall is monitored with ground data, satellite data is not considered to be accurate enough.

Data/Information Sharing

GMet provides some ministerial departments with data for free, whilst private companies pay for the information unless they are agriculture-related. Data on forecasting, heavy rainfall and GMet mentions that daily forecasts are communicated to the forecasting team of NADMO.

Constraints and challenges

Weather stations are not all operational. UNDP supports the purchase of automatic climate stations. Data is manually entered into Global Telecommunications System (GTS). There is lack of (trained) man-power and the research area is not well-developed, e.g. to work on early warning systems like flood forecasting. The agency is careful in raising false alarms if there is an issue with the credibility of the information.

4.2.10 Ghana Atomic Energy Commission & Ghana Space Science & Technology Institute

Role in Disaster Management

The Ghana Atomic Energy Commission hosts the Ghana Space Science and Technology Institute (GSSTI), which was created on 2nd of May 2012 and has not developed an applications programme yet. The GSSTI is represented on several technical committees led by NADMO and is involved in climate change issues with the Ghana Meteorological Agency.

Use of space and geospatial technologies

GSSTI has the ambition to become the driver of Ghana's space technology development programme. The institute is currently collaborating with South Africa to develop a robust Astronomy programme and participate in the square kilometre array (SKA) project. To this end, the institute has commenced a programme that will convert a 32m radio communication dish into a radio telescope for space weather observation. Furthermore, the institute plans to commence capacity building for the SKA project in 2017. There is no experience yet with satellite imagery and how to access satellite imagery data.

Data/Information Sharing

The institute currently does not have Earth observation satellite imagery. Nevertheless, efforts are being made to develop a ground receiving station to facilitate access to earth observation satellite data without necessarily launching its own satellite.

Constraints and challenges

The institute is a new organisation and is in urgent need of archival satellite datasets for Ghana. As a follow-up activity, Landsat archival data over Ghana can be sourced, e.g. from the University of Maryland Global Land cover Facility (<http://glcfapp.glc.f.umd.edu:8080/esdi/>)

4.2.11 Hydrological Services Department (HSD)

Role in Disaster Management

HSD works with NADMO in providing hydrological model forecasts, in order to warn communities of flood events. It developed a flood early warning system in the White River area with assistance from a Dutch consultant. The Department has flood risk maps for Ghana but they do not contain the so-called annual exceedance probability (AEP) lines⁵. HSD is part of the Water Resources Committee, which is the umbrella organisation for water related issues, e.g. they cooperate for determining the water extraction levels for mines and agriculture. HSD monitors water levels with telemetric stations (SMS communication) which provide real-time hydrographs. HSD looks at the impact of building structures like dams or unplanned constructions that obstruct drainage systems, for which it cooperates with the Town and Country Planning Department, but at the district level, the cooperation is apparently less effective. HSD has modelling of the Volta River in place with assistance from Netherlands. That provides the capacity to predict and model floods.

Use of space and geospatial technologies

HSD is not responsible for flood mapping and does not also have the capacity either for spatial analysis. There is one staff trained in GIS, who works with QGIS and spatial data like land use maps and DEMs but satellite imagery are not used. Meteorological data, including meteorological satellite data is obtained from the internet.

Data/Information Sharing

Hydrographs are not made public, but flow data is shared with Government Agencies (Water Resources Commission, Ghana Meteorological Agency, Water river authorities, NADMO and the Water Research Institute).

Constraints and challenges

HSD sees a role for NADMO to play in doing potential impact analysis assessments. It has technical capacity but funding and institutional strength are a big challenge.

4.2.12 Ghana National Fire Service (GNFS)

Role in Disaster Management

The mandate of the GNFS includes the prevention and management of undesired fires and the enforcement of fire service regulations. GNFS has developed standard operation

⁵ The Annual Exceedance Probability (AEP) refers to the probability of a flood event occurring in any year. The probability is expressed as a percentage. Flood map shows an estimate of the areas likely to be flooded during a 1% AEP flood - also previously known as the 100 year flood line

procedures, simulations exercises, disaster management procedures (preparedness and awareness creation), search and rescue, firefighting and investigation, medical evacuation, post disaster reconstruction. GNFS receives daily weather data from GMet.

Use of space and geospatial technologies

GNFS had 40 staff members trained in GIS by the Department of Geography, University of Ghana; it does not apply space technology in its operations but it has plans to set up a geospatial centre, for which it has signed a memorandum of understanding with the University of Ghana. GNFS does not own any GPS equipment or satellite phone and there is lack of a street numbering or geo-locating of numerous areas in Accra in general. GNFS is eager to develop capacity to use geo-referenced information and technology to facilitate its ability to respond rapidly to emergencies and would like to receive training from UN-SPIDER and/or NADMO.

Data/Information Sharing

GNFS receives information from other agencies to identify where to look for people e.g. in collaboration with police, NADMO, and the military and civil society groups in the area. Dissemination of information is done through a broadcasting and alerting system. GNFS does not have any past data on wild fire locations, severity and climatology. The lack of street naming/numbering is an important constraint that should be solved by the Survey and Mapping division/Town and Country Planning Department.

Constraints and challenges

The fire service does not apply space technology in its operations. Rapid response of the service to emergency calls is hampered by the lack of adequate street names and street maps. The Service lacks technology like GPS and portable weather observation kit. GNFS challenges the interagency coordination and training. There is an issue with overlapping mandates between GNFS and NADMO, which requires clarification. Moreover, GNFS desires to be well equipped to carry out its mandate.

4.2.13 Geological Survey Department (GSD)

Role in Disaster Management

The GSD is responsible for geological information for the land part, e.g. for a seismic risk map, which is a potential disaster in Accra. GSD has a network of six stations that measures earth movements and it has developed geological site information maps which includes geological risk/seismic map which were provided to NADMO (Geological Committee). GSD does not have a real influence in town planning since there is no obligation to get an

assessment from the Department if one wants to construct a building. There is building code of standards and practices in place, which take into account the seismic risk, however, the enforcement is weak (report to Hyogo conference, 2005). GSD makes recommendations for waste disposal sites. Large part of the water provision uses ground water, however a ground water map does not exist, which would be the responsibility of the Water Research Institute. Soil maps are made by the Soil Research Institute (CSIR)⁶.

Use of space and geospatial technologies

GSD conducts spatial research through the CSIR, where a geologist from the department is working. About 10 people work there with ArcGIS, principally for the mining industry. The Department gets airborne electromagnetic inversion data for the whole country which is relevant for mining purposes. For geological maps, Landsat and aerial images are used but only as a reference.

Data/Information Sharing

Although GSD makes data available, it does not have the mandate to enforce restrictions, e.g. for buildings in seismic areas.

Constraints and challenges

GSD does not have capacity for working with space-based information.

4.2.14 Environmental Protection Agency (EPA)

Role in Disaster Management

EPA works with NADMO, especially on capacity building on the use of geographic information in cooperation with the University of Ghana and CERSGIS. EPA cooperates in projects on climate change e.g. within the Africa Adaptation Programme and Early Warning System (EWS, www.ewsghana.com) as well as the Ghana Environmental Management Project (GEM). EPA is mandated to regulate pollution issues, however, private companies are responsible for assessing the risks.

The Environmental Protection Agency (EPA) in conjunction with the National Development Planning Commission (NDPC) is working closely with all the Ministries, Departments and Agencies (MDAs) to mainstream climate change in their plans and the budgeting process.

Use of space and geospatial technologies

⁶ Not visited by the TAM team.

EPA has 3 persons working with GIS e.g. in mapping of sensitivity of coastal zones to identify the areas that are sensitive to oil spills. It uses remotely sensed data to a limited extent due to the high costs. The World Bank has funded a GIS project in the southern zone for monitoring and to capture baseline data to monitor changes over time.

Data/Information Sharing

EPA referred to the 'National Framework for Geospatial Information Management' (NAFGIM) that was a spatial data infrastructure (SDI) initiative in Ghana which started around 2000. NAFGIM was developed as an integral part of a national effort to manage spatial data pertaining to the environment and natural resources. It sought to bring together technology, policies, institutional resources and standards to enhance the production, storage, access and utilization of geographic data and information. NAFGIM is no longer functional but Ghana is again embarking on another SDI initiative (Owusu-Banahene et al. 2013). Meanwhile, UNEP has taken the initiative to revive the African Environment Information Network (EIN) for accessing data hosted by GMet and the Ministry of Agriculture.

Constraints and challenges

It is of concern that some agencies pay for data and others do not.

4.2.15 Ghana Statistical Service (GSS)

Role in Disaster Management

The Ghana Statistical Service (GSS) reports directly to the President. The office collects datasets including economic, social, demographic, agriculture and environment. Census (held every 10 years) and household survey data sets are provided to NADMO for their analysis. GSS does not receive data on disasters from NADMO and GSS is not represented on the technical committees. GSS cooperates with the Health Department; it is currently implementing a health survey with UNICEF and a large number of other organisations. The Service jointly implements an agricultural census with the Ministry of Food and Agriculture.

Use of space and geospatial technologies

The GIS unit consists of 12 persons who are using ArcGIS and GeoMedia, principally for thematic mapping of census/survey results. It does not perform spatial/geostatistical analysis, but is interested to develop these skills. GSS uses VHR satellite imagery to digitise enumeration areas (statistical sample units). It cooperates with CERSGIS for remote sensing processing. The office is currently planning to acquire high resolution satellite imagery for the entire country using resources from stakeholders so that multi-user licenses will be

obtained and shared among other agencies that contributed resources to the data purchase. GPS are used for the census and household surveys; each team takes two GPS units and a paper map. UNFPA has paid for GPS equipment (40-52), training and software. A plotter was provided by DFID and the World Bank.

Data/Information Sharing

Statistical data (census/survey data) are made available on the website; up to the regional level, these data are free of charge, while at the district level it has to be paid for. Similarly, data requests that require additional processing and field work is paid for by the client. The district governments get the detailed information up to the enumeration (sample) level. GSS gets spatial baseline data from the Survey Department without any costs.

Constraints and challenges

Well equipped, but needs capacity building to develop analytical skills.

4.2.16 Ghana Ports & Harbour Authority

Role in Disaster Management

The Ghana Ports and Harbour Authority is responsible for dealing with disasters in the port. Its Safety Department is equipped to the standards of the Fire Service. The port has its own hospital, ambulance and medical personnel. There is no formal linkage with NADMO to deal with disasters and the authority is able to handle (small) disasters like minor oil spills. For larger disasters, the authority depends on the Ghana Marine Authority and international support.

Use of space and geospatial technologies

The Authority has an automatic navigation system following international standards. Communication means are wireless and wired. No further space-technology is applied.

Data/Information Sharing

Potential problems are when hazardous materials leave the port and NADMO should be informed. There is no communication link with NADMO for these cases.

Constraints and challenges

See former points.

5. Assessment by the mission team

The following sections give an assessments made by the TAM team on the base of the meetings and discussions held during the TAM, including TAM workshop with 50 officials from the government, UN, academia, NGOs and private sector (list provided in Annex IV).

5.1 Policy and Coordination

Renewal of Disaster Management Plan provides an opportunity to include space-based technology

The TAM team concludes that the institutional structure of the different institutions related to DRM activities is currently closely in line with recommendations by the Hyogo Framework for Action 2005-2015. This is reflected by the National Disaster Management Plan, the Standard Operating Procedures of NADMO and the Action Plan. In 2015, the National Disaster Management Plan is due for renewal, which offers the opportunity to include the application of space-based technology in disaster management cycle targeting the early warning, response and recovery phases.

Coordination mechanism for disaster management is available (thematic technical committees) which brings in different ministries/departments already working with geospatial information

The thematic technical committees are well positioned to play the coordinating role among the different institutions involved in the different phases of disaster risk reduction and management. A coordinating body is very much essential in such an interdisciplinary and inter-institutional domain. Different departments and ministries have their own geospatial databases but there is no national coordinator or a national spatial data infrastructure. Strong geospatial expertise exists within CERSGIS, Environmental Protection Agency, the Forestry Department, Survey and Mapping Division as well as the Universities such as University of Ghana and the Kwame Nkrumah University of Science and Technology (KNUST). Most of these agencies are working on risk assessments and early warning, e.g. for floods and forest fires; CERSGIS is well equipped and provides services on varied issues including maps for all disaster management stages, including disaster response maps. CERSGIS has provided services to various agencies, including NADMO, however it does this on a (semi-) commercial basis and their work sometimes overlaps with the mandate of the Survey and Mapping Division. There is no Contingency Plan defining the role of each agency that works with geospatial data and the role of each agency during a disaster response situation.

NADMO has the opportunity to serve as the coordinating body, supported with the technical knowhow of the sub-committees, to address comprehensive disaster management

NADMO clearly sees its coordinating role for disaster management and the necessary inclusive character of the crosscutting topic of disaster management and the authority fully commits itself to the role as coordinating body.

However, the management of geospatial data is new for NADMO and it therefore requires major efforts to build up a data management policy, infrastructure and expertise. With the establishment of the National Risk Observatory, NADMO could provide the relevant coordination effort among different institutions that provide baseline data, other disaster-relevant data and to guide the modelling and analysis of geospatial data. The support from all other institutions is essential for this and for NADMO to fulfil this mandate, a strong policy framework is necessary. NADMO will need strong support from agencies like UNDP, CERGIS and the University of Ghana to build up its capacity.

Early warning and risk plans are made on an *ad hoc* projects base and are not yet an integrated part of the disaster management cycle, lack regular updates and a feed-back mechanism from the lower governing levels. There is therefore a role for the NADMO headquarters in Accra to improve that communication in order to get information from the lower governing levels.

Information sharing policy is not in place.

Data sharing currently takes place only via informal networks or based on bilateral agreements or through sales between organisations. It was felt that the lack of clear policies strongly hinders the sharing of information and data and strengthen a 'silo-approach'. This is not only valid for external users of data but also within governmental institutions. Therefore, a policy outlining the use and sharing of geo-information is an important prerequisite which is currently lacking and should be established in the near future. CERGIS seems to have access to the most relevant data. However, other departments and institutions have limited access to base data as well as thematic data. Financial charges for data are perceived as a problem by several organisations and it is not clear whether the criteria for charging are consistently applied.

Uncertainty about the development of a national spatial data policy/infrastructure

The National Spatial Data Infrastructure (NSDI) is a framework of spatial data, metadata, users and tools that are interactively connected in order to use spatial data in an efficient and flexible way. Another definition is the technology, policies, standards, human resources, and related activities necessary to acquire, process, distribute, use, maintain and preserve

spatial data. The use of space-based information inevitably calls for the availability of a NSDI. NSDI forms the base to use any other information that is spatial in nature, including remote sensing data. Additionally, remote sensing data can be considerably more useful when integrated with other baseline and ancillary data.

Currently, several organisations plan to restart or lead the creation of a National Spatial Data Infrastructure (NSDI). Apparently it is not yet defined who will coordinate the initiative, which can be a determining factor for a success full initiative.

5.2 Data and access/availability

Thematic mapping done, involving different ministries/departments (e.g. EPA, GSS, CERGIS, GMet, Forestry Commission, Hydrological Services Department)

Different ministries and departments are involved in the mapping and maintenance of various thematic datasets. Such a sharing of responsibilities is important and should be allocated according to the specific expertise and responsibilities. However, disaster risk management, as an interdisciplinary field, requires access to such data. Again, if NADMO wants to achieve a coordinating role, it will have to strengthen the ties with all these line ministries/departments. It is revealing that UNDP and UNEP are playing, or have played, this coordinating role, e.g. in the development of the National Risk Observatory. NADMO should take over these responsibilities or work with these agencies to build capacity.

The Survey and Mapping Division and the Ghana Statistical Service are mandated to provide baseline data.

The Survey and Mapping Division is the institution providing the required geospatial baseline data (topographic maps, vector layers, satellite data, socio-economic indicators). However, their topographic information, maps and associated vector layers and partly remote sensing (aerial photos) data are outdated and currently in the process of being updated. The Ghana Statistical Service provides population and socio-economic data. The last census was conducted in 2010. Geographic data collection is sometimes done by different agencies, e.g. the mapping of roads, which is mentioned as responsibility for the Survey and Mapping Division but the mapping is done by the Feeder Road Department (Ministry of transport) and (partly) outsourced to CERGIS. In this way the department acquires baseline data on its own, which leads to a dispersed situation of up-to-date baseline data.

The Ghana Statistical Service collects data on societal infrastructures (such as school, health post locations, etc.) through its census (the last one was in 2010). Data collected is available online. Note should be taken that such baseline data would be more beneficial if accessible on a common data sharing platform.

Little knowledge about the access to satellite data

Unfortunately, little knowledge about getting satellite imagery data exists, e.g. through mechanisms like the International Charter on Space and Major Disasters. None of the organisations indicated that they are aware of such mechanism. The organisations (University of Ghana, CERSGIS) that use satellite images, obtain them commercially or freely from the Internet. It is also noteworthy that the Survey and Mapping Division (SMD) is mostly dependent on aerial photos and considers satellite imagery as unsatisfactory for their purposes, whereas Very High Resolution (VHR) satellite imagery is often very close to the spatial resolution of aerial photos and easier to purchase.

Identified difficulties in getting data from GSS and SMD

During the mission, the TAM team frequently observed difficulties in accessing data from the Survey and Mapping Division and the Ghana Statistical Service. This may be hindered by the fact that both GSS and SMD also need to generate revenues from its data or is limited due to current legislations in place. Nevertheless, the sharing and access of such baseline data is very important to satisfy the needs of an integrated disaster risk management.

Lack of awareness about the use and existence of geospatial data

A number of organisations involved in disaster management have not yet used space-based information and/or geospatial information in general in their planning or implementation. This situation is the result of threefold challenges: (i) lack of awareness amongst decision makers about the potential and usage of space-based information in disaster management; (ii) in certain institutions, limited technical expertise to make use of such information; and (iii) lack of national policy to promote sharing and use of such information in all sectors of the government (as frequently outlined). Due to informal exchange of data and no regular common update and policy, the awareness of the availability of data is limited. Also currently no formal network exists which could help to overcome this issue, often associated with the required communication between the different data providers and users.

Metadata generation needs improvement, including standardization

To increase the awareness of the availability of geographic data, it is essential to have proper metadata following national/international standards. Currently, it has been observed that data is (often informally) shared among institutions and departments, where data may be updated and modified. Metadata profiles and standards need to be developed to achieve a long-term sustainability of data and its quality.

Informal data exchange exists among several departments

Current data sharing is often based on informal networks. Although this may help to overcome the minimal needs, this cannot be seen as sustainable for the future. Again, it is mentioned here that data sharing mechanisms need to be urgently addressed. Existing best practices from the region, such as the case from South Africa with one of the most advanced legislations worldwide, should be taken up and possibly translated to the situation and requirements in Ghana.

5.3 Capacity Building and Institutional Strengthening

Capacities to use RS/GIS exist within several organisations

It has been observed that crucial capacities in GIS exist in various Departments (e.g. the University of Ghana, Survey and Mapping Division, CERSGIS, EPA, Forestry Commission). Among the above mentioned, the Survey and Mapping Division, CERSGIS and the University of Ghana have most of the trained staff in RS/GIS. Expertise exists with regard to image processing and remote sensing specifically at CERSGIS, University of Ghana and to some extent, at the Survey and Mapping Division. The identified expertise has much potential to be extended to the other organisations as well. This requires proper capacity building plans that are regularly updated, which seem to be lacking since trainings seem to be *ad hoc* and sometimes even neglected (see the availability of training capacity at the University of Ghana).

The translation of RS/GIS capacity into direct benefits for disaster management has been hampered by the absence of an integrating entity. This gap can be seen as an opportunity for further strengthening the inter-departmental cooperation. Strengthening capacities of provider organisations like Survey and Mapping Division, CERSGIS, etc. and user organisations like NADMO, will certainly form a good foundation for sustainably introducing applications of geospatial technologies in disaster management.

Several institutions are involved in international projects involving space-based and geospatial information

It was perceived as positive that various organisations (e.g. Survey and Mapping Division, University of Ghana, CERSGIS, Hydrological Services Department, NADMO) are supported by or have cooperation with international institutions/organisations, among them UN organisations. This ranges from collaborations in the domain of hazard and vulnerability assessment, training in GIS/RS, towards the exchange of experiences at the civil protection

level. NADMO is currently receiving support from the US (FEMA), but is still facing a steep learning curve and has only assigned 2 GIS staff. Based on the TAM experience, national agencies in Ghana could support NADMO in building up the expertise. Thus, the TAM team also raised the question whether international consultants are always required, e.g. in the framework of the CREW project.

Probably, the exchange and dialogue between South-South countries could be strengthened (e.g. with RECTAS, the Regional Center for Training in Aerospace Surveys in Nigeria), which would allow the transfer and integration of lessons learnt from a similar environment. Such international collaboration strengthens the network and allows the exchange of ideas.

NADMO needs capacity to make use of the thematic data provided by different institutions

As NADMO uses and applies data and information products (in the ideal case) provided by the different thematic institutions, currently NADMO is at the initial phase for handling geographic data and has not yet build any capacity on processing and analysing the data yet. As already mentioned, NADMO has started receiving support from the US to build the infrastructure and capacity for geographic data processing; nevertheless, at the same time, CERSGIS and the University of Ghana have already well equipped offices and also motivated staff members, who have knowledge and expertise to work with geospatial information. Cooperation with these institutions could be built into an overarching capacity building framework.

Awareness and appreciation at decision-making level is required

Several stakeholders mentioned constant need for awareness programmes for decision makers at mid and high-levels. With the constant dynamic development and advancements in related geo-spatial technologies, the way space-based information is accessed and used changes dramatically. Decision makers need to be informed of these technologies and their benefits in order to implement policies that promote appropriate uptake and usage in national development plans, including disaster management and related sectors of natural resources development and environmental management. If NADMO wants to incorporate not only geoinformation but other space technology products as well, it should establish a special awareness raising strategy. The definition of clear goals on “What, Where and How” for the use of space-based technology would be a first necessary step. This should result in more availability of funding for data management and analysis.

5.4 Communication/ navigation technology

The TAM team observed a differentiation in the availability of communication technology per organisation. NADMO seems to be well equipped with radios and GPS whereas other

response agencies rely on mobile phones and indicative location positioning. In this regard also, the street-naming and numbering project should be mentioned, since this project will help to streamline the position determination and communication. However, it would be highly recommendable that some selected agencies other than NADMO receive technology for (satellite-based) positioning equipment and communication tools that match standards of the main disaster management organisations (crisis communication standards of WFP).

6. Recommendations

The mission team would like to emphasize that the proposed activities should not be implemented piecemeal as isolated activities since disaster management is an overarching issue that needs consideration of DRR elements in all sectors related to development and environmental management. The proposed recommendations about capacity building will have to go hand-in-hand with institutional strengthening, fostering information flows and policy level interventions. The capacity building activities will be in vain if a staff being trained do not have a formal role to provide certain services in the national disaster management system, or are without the necessary resources to carry out these functions. The space-based emergency information products will not contribute to a better emergency response if disaster information flows within the country is too slow and end-users do not have the technical capability to evaluate the information received and integrate it into their plans. Finally, generating space-based information products requires specialized skills. To be successfully used in Ghana, it requires strong institutional support through appropriate disaster management legal instruments, clear data sharing arrangements and a great willingness to cooperate across different governmental and non-governmental institutions.

6.1 Policy and Coordination

- a) The Government of Ghana should take the opportunity of the update of the *Disaster Management Plan and Contingency Plans* to incorporate space-based and geospatial information and to define the role for providing/analysing geospatial data by each agency. It is recommended that the policy plan mentions the linkages between the disasters related entities and organisations that manage geographic information. Their role in information management should be explicitly defined since these are useful existing sources of knowledge and expertise in the country. NADMO as the lead agency in disaster risk management should take lead in the updating of the policy.
- b) Existing risk maps at district level should be extended to come to a national coverage. Early warning and risk plans are made on (*ad hoc*) project basis and are not yet an integrated part of the disaster management cycle; these also lack regular updates and a feed-back mechanism from the lower governing levels. There is therefore a role for the NADMO Headquarters in Accra to improve that communication in order to get information from the lower governing levels. Risk maps should be mentioned in the national disaster policy and there should be a timeline to update them, include climate change factors and come to a continuous hazard risk monitoring, which should be used in the contingency plans as real

planning tools. The existing contingency plans require a feedback mechanism with data on disasters from the districts. NADMO should drive these changes but would require support from UN organisations like UNDP and UNEP.

- c) A national coordination is required for streamlining the geographic data policy, set standards (on metadata, formats, etc.) and to make data available in a transparent manner. There is also a task for the Survey and Mapping Division. In the short term, the purpose should be to ensure that geospatial data becomes more easily accessible through data/information sharing policy. An assessment should however be made on what practicality, legal and financial impacts of free data will be. In the long-term, Ghana should envision a centrally organised National Spatial Data Infrastructure. A key component for the success of a NSDI is strong coordinating body; lessons learned from the past when the former SDI initiative NAFGIM was implemented are well documented and should be used to avoid errors made in the past and give detailed suggestions on the steps to take, see therefore: Owusu-Banahene et al. (2013), Engelhardt (2012) and Yawson et al. (2010). A new NSDI initiative should also be coordinated with other open information initiatives (e.g. African Environment Information Network).
- d) The potential of space-based information and geospatial data should be recognized and prioritized at the policy making level, including finance. If NADMO and the Ghana Space Science and Technology Institute want to incorporate not only geoinformation but other space technology products as well, it should establish a special awareness raising strategy. The definition of clear goals on “What, Where and How” for the use of space-based technology would be a first necessary step. This should result in more availability of funding for data management and analysis.

6.2 Data and Access

- a) A more in-depth study is needed to assess the internal pathways for data dissemination within Ghana government agencies. This study should be done by the responsible ministry (e.g. Ministry of Information or Communication) and eventually with external support. Such a study can then be used to review the national data policy and develop more consistent guidelines on data access and pricing policy. The study could be extended to the non-governmental institutions mentioned in this report and consider the current role that they play or could play in the future for facilitating or using geo-spatial data. Existing best practices from the region, such as the case from South Africa with one of the most advanced legislations worldwide,

should be taken up and possibly translated to the situation and requirements in Ghana.

- b) The TAM team recommends that the points of contact and role of institutions in the use of international mechanisms (International Charter, Copernicus GIO Emergency Management Service) for acquiring EO data/products are clarified and formalized. NADMO can obtain the role of “Authorized User”, meaning that it would have the right to activate the international mechanisms to obtain geographic data and products for disaster management. A central coordinator for acquiring these data will avoid delays due to communications between actors not directly involved in the management of operation.
- c) In general, the use of satellite imagery for disaster management could be enhanced. For creating more awareness about the use of space-based technology, the Ghana Space Science and Technology Institute could take this role on.
- d) A new NSDI initiative should be fuelled by the full commitment of all stakeholders to foster sharing of data and information. This requires a strong coordinating body for which a government agency should be appointed in a full participative process, e.g. through a stakeholders workshop. Lessons learned from the past and from neighbouring countries should be used to start such a process. The Survey and Mapping Division and the Ghana Statistical Service have the mandate to develop base data and could initialize a new NSDI initiative, although they do not necessarily have to be the permanent coordinating bodies, which will depend on the decisions taken during a stakeholders meeting.

6.3 Information management

- a) There is the need for a permanent operational Geographic Information unit for disaster response. The initial steps are made to create such a unit at NADMO. The unit can be based at the Emergency Operations Centre and should grow to obtain 24/7 alertness capacity. NADMO will need further support to build this capacity which can also be used from capacity in Ghana, e.g. CERSGIS and the University of Ghana.
- b) All institutions should be kept up-to-date on the developments in space-based technology, e.g. new satellite imagery, navigation and communication tools. The Ghana Space Science and Technology Institute has a mandate for this purpose and it

could take up the task to promote awareness of and the functioning of the international mechanisms to acquire space-based information.

- c) Data management needs to be reframed to provide uniform access to all humanitarian and development organisations. Metadata should be considered as an important component of the data management. The current practice is to go from ministry to ministry to get access to the required data and without having a complete awareness of the existing datasets. This practice needs to be reformed by creating NSDI facilities for geospatial management. While data is generated and owned by respective organisations, NSDI would be a way to keep metadata and access to the data to all humanitarian and development partners including NADMO. A NSDI will also ensure interoperability of the data, such as baseline data with uniform data standards. See the recommendations on NSDI in paragraph 6.1 and 6.2.

6.4 Capacity Building and Institutional Strengthening

- a) The focus for NADMO could be twofold: on the one hand, it could focus on the application and use of existing thematic data during the risk identification and assessment phase. In this case, it is important that NADMO will not take up the responsibilities of the different institutions responsible for specific thematic areas. On the other hand, NADMO could be the agency that coordinates the provision of data immediately after a disaster event, i.e. during the response and relief phase. In this case, NADMO would activate disaster data provision mechanisms in order to get relevant data and subsequently NADMO would act as the data provider for other agencies operational in the field. This would require a 24/7 availability of staff and specific training on disaster response.
- b) It is necessary that capacity building plans are continuously revised and updated according to the available staff and the needs of the organisation. Key organisations like Survey and Mapping Division have the need for regular updates on the use of GIS/RS software and of new software licenses. The focus that NADMO chooses should be expressed in the policy documents and also be used for defining the required training needs.
- c) Based on the TAM experience, national agencies in Ghana could support NADMO in building up the expertise. Use the available capacity in Ghana (e.g. University of Ghana). Need to leverage upon the training capacity existing within the country

(Universities etc.), although international organisations could support with resources.

- d) The exchange and dialogue between South-South countries could be strengthened (e.g. with RECTAS, the Regional Center for Training in Aerospace Surveys in Nigeria), which would allow the transfer and integration of lessons learnt from a similar environment. Such international collaboration strengthens the network and allows the exchange of ideas. UN-SPIDER can assist in this process and NADMO could use the capacity from the Regional Support Office (e.g. RECTAS, UN-SPIDER Regional Office) and take advantage of the availability of geographic information support: ITC, FEMA, Universities..
- e) Staff in all departments should be informed and trained about the use of open source data and software programs. Much open source data as well as software programs available on the web and therefore lack of financial resources should not hamper the acquisition of software. As an alternative, provision of commercial software could be obtained through public/private partnerships, since funding for purchasing commercial software is often a problem.
- f) Disaster risk reduction education and training should be integrated in the curriculum of schools and Universities at all levels. In addition, Universities should develop post graduate education in DM. This would be a task of NADMO in coordination with the Ministry of Education.
- g) Organize a national course to develop capacity in open source software (QGIS, SPRINGS, ILWIS, etc.) and application of using satellite imagery for disaster management support. The use of open source software avoids problems with acquisition of software licenses after trainings. The training could be given by national or international training institutes but could be organized by the Survey and Mapping Division/CERSGIS and with support from UN-SPIDER and FEMA, Organising a national course involving several disaster management related organisations has the benefit of creating awareness about existing datasets in the country. Such a course could create this awareness by having each organisation to use their own data presenting the results of their spatial analysis.

6.5 Communication/navigation technology

- a) Some selected agencies other than NADMO should receive technology for (satellite-based) positioning equipment and communication tools that match standards of the main disaster management organisations. GPS equipment needed for response services (e.g. Fire Services).

7. Next steps

- 1) Incorporate TAM recommendations in UN and Government led programmes.
- 2) UN-SPIDER facilitation (workshops and training programmes, leveraging on opportunities provided by partners).
- 3) UN-affiliated centres for long-term training.
- 4) Bilateral cooperation with TAM experts.

ANNEX I Mission schedule

Day	Time	Organisation
25.11	08:30 – 11:00	NADMO (incl. First Team Meeting) Presentation of NADMO
	11:30 – 13:00	UNDP
	LUNCH	
	14:00 – 15:30	Environmental Protection Agency (EPA)
	16:00 – 17:30	Survey and Mapping Division
26.11	08:30 – 10:00	Geography Department, University of Ghana-Legon
	10:30 – 12:00	CERGIS-UG, Legon
	LUNCH	
	13:00 – 14:00	Forestry Commission
	14:30 – 16:00	Ghana Atomic Energy Commission (GAEC)
27.11	08:30 – 10:00	Ghana Meteorological Agency
	10:30 – 12:00	Geological Survey Department
	LUNCH	
	13:00 – 14:00	Regional Maritime University
	14:30 – 16:00	Ghana Statistical Services
28.11	WORKSHOP	From 8:30 to 17:00 @ NADMO
29.11	08:30 – 10:00	Team discussions and preparation for debriefing
	10:30 – 12:30	Kofi Annan International Peacekeeping Training Center
	LUNCH	
	14:00-17:00	High Level De-Briefing @ NADMO

ANNEX II Short description of the visits

Day 1: 25 November 2013, Monday *National Disaster Management Organization*

(NADMO): The TAM started with a welcome by the National Coordinator of NADMO (Kofi Portuphy), TAM coordinators from NADMO, Mr. Yao Kiatchey (Assistant Chief Director) and Mr. Abrokwa Koranteng (Director Training) and all departmental heads of NADMO namely Administration, Geological Disasters, Man-Made Disasters, Hydro-meteorological Disasters, Fire/Lightning Disasters, Pests & Insects Infestations Disasters, Disease Epidemics Disasters, Climate Change and Operations (Urban Search and Rescue Unit). The UN-SPIDER team presented themselves and Mr. Coen Bussink explained the purpose of the mission. An initial overview was given of the organisational structure and functioning of NADMO. The role of NADMO in disaster situations was discussed as well as the collaboration with other disaster management related institutions. Statements were made about the current use of geo-spatial data at NADMO and the policy to improve the use of these data and space-based technology.

United Nations Development Programme (UNDP): The team was welcomed by Mr. Paolo Dalla Stella (Sustainable Development Analyst), Mr. Namho Oh (Programme Analyst), and Mr. Stephen Kansuk (Programme Officer). Later, the UN Resident Coordinator Ms. Ruby Sandhu-Rojon joined the group and gave an overview of the current and past projects on disaster risk mapping projects and their involvement with the work on disaster management in general and with NADMO in particular.

Survey and Mapping Division: Mr. W.K. Opoku and Mr. Chris Dzebglor of the Division welcomed the TAM team to their premises and briefed the team on the mandate of the division and the mapping work done at the moment and in the near future. Some maps were shown at the Cartography Laboratory.

Day 2: 26 November 2013, Tuesday

The group was split into two groups, based on the expertise of the team members. Each team was made up of at least one UN-SPIDER staff member and an officer from NADMO. The following organisations were visited by the sub-teams.

Department of Geography and Resource Development, University of Ghana, Legon: Dr. Alex Owusu received the team at the GIS Laboratory. He informed the team of the existing capacity, facilities and the training this department provides to other institutions. He also indicated the thematic topics that the department is involved with.

Ministry of Food and Agriculture: Mr. Emmanuel Asante-Krobea (Director of Crop Services), Mr. Rudolf Atome (Assistant Director), Ms. Rejoice Ayifili Klabilias Akuyo (Assistant Director), Mr. Brian Agyemang-Boateng (Principal Accountant) welcomed the team and gave a brief overview of Head Office activities. It was decided that the UN-SPIDER group should have

more focused meetings with Mr. Emmanuel Asante-Krobea, the Director of Crop Services within the Ministry. Mr. Asante-Krobea explained the cooperation between Crop Services and NADMO and gave an overview of how the organisation works with geographic risk information.

Centre for Remote Sensing and Geographic Information Services (CERSGIS): Mr. Selassie Adanu (Environmental Systems Specialist) and Mr. George Owusu (Applications Specialist) invited the team to the office at the University Campus. The company was founded by the University of Ghana and the Environmental Protection Agency and is a self-supporting non-profit organisation with some of its services being perceived as of commercial nature.

Town and Country Planning Department: The team was received by the Director, Mr. Kwadwo Yeboah, the Deputy Director, Mrs. Gladys Rugha and the GIS officer, Mr. Prosper Detornu. They explained how spatial data is used and how they get the data and the products required for spatial planning and risk management.

The Forestry Commission: The visit was made to the main offices of the Forestry Commission, where the following staff received the team: Mr. Kwakye Ameyan (Director Operations), Mr. Luri Kanton (Operations Manager) and Mr. Kwakye Ameyaw (Forestry Services Division). The Forestry Commission has a GIS/Remote Sensing Unit but it is located in Kumasi in the Ashanti Region outside Accra and too far to be visited during the week. The use of remote sensing, communication and navigation technology was discussed, especially in relation to wild fires.

Ghana Atomic Energy Commission (Ghana Space Science & Technology Institute): The Space Science and Technology Institute is hosted by the Ghana Atomic Energy Commission. Mr. Michael Obeng, Prof. Nyarko, Dr. P. K. Ashilevi, Mr. Joseph Amoako, Mrs. Rose Boateng, Mrs. Mary Boadu and Mrs. Paulina Amponsah received the UN-SPIDER team. The Institute has been in existence for almost 3 years. However, the institute is still at its initial stage but aims at becoming the main actor for space technology in Ghana.

Day 3: 27 November 2013, Wednesday

For day 2, the group was split according to the expertise of the team members. For each team, at least one UN-SPIDER staff member and an officer from NADMO were present.

Ghana Meteorological Agency: The team was received by Mr. Andrew Yaw Nkansah (Director – Scientific Division). The team could get a good picture of the actual use of weather forecasting data, the required infrastructure and the cooperation with other agencies. The Agency has 500 staff of which 150 are in Accra.

Hydrological Services Department: Mr. Sylvester Darko, Mr. Seth Kridjodil and Mr. Obed Minkah are working for the Hydrological Services Department, where the team was received

at the regional office in Accra. The use of flood models, the cooperation with water-related institutions and the use of geographic data was discussed.

Ghana National Fire Service: About 30 persons from the Service received the team at the station. The meeting was well prepared and a presentation was given on the capacity to use GIS, the mandate to handle disasters and difference/similarities with the mandate of NADMO.

Geological Survey Department: Mr. Kwame Boamah (Head of Geophysics and Information Management), Mr. Daniel Boamah (Head of Geochemistry and laboratories) received the TAM team and described the use of GIS and the infrastructure for measuring seismic activities and mapping geohazards.

Environmental Protection Agency: Mr. Roger Lewis Leh, Mr. Ebenezer Appah-Sampong, Mr. K. Y. Oppong-Boadi, Mr. Adeling Ashong received the team at the head office of the Environmental Protection Agency. The current use of GIS and remote sensing at the institute and collaboration with other institutions was extensively discussed.

Ghana Statistical Service: Mr. Baah Kwakye (Acting Deputy Director for Technical Support), Mrs. Rosalinda Quartey (head of GIS Unit) and Mr. Robertson Adjei (GIS Specialist) gave an overview of the data the Service collects, the use of GIS/Remote Sensing/GPS and data distribution.

Ghana Ports & Harbour Authority: An overview was given on the use of navigation and communication technology, safety equipment and infrastructure as well as the preparedness for disasters.

Day 4: 28 November 2013, Thursday

National Workshop on the Use of Space Technology in Disaster Risk Management

The workshop was attended by 50 participants (annex IV) from governmental institutions, NGOs, academia and international organisations that are actively involved in emergency response services, disaster risk management or are users/producers of geographic information. The workshop was facilitated by Mr. Abrokwa Koranteng (NADMO). Mr. Coen Bussink gave a presentation on the work of UN-SPIDER, Mrs. Longfei Liu from NDRCC in China presented the mechanisms to activate the International Charter for disasters, including a video on this topic and Mr. Godstime James showed the work of NASDRA in Nigeria and applications of getting satellite imagery after a disaster. Subsequently, group discussions were held during which all participants were invited to think about the current and the potential use of space technologies for disaster management within their own organisations. The discussions were held in four teams, two groups with representatives from emergency response agencies and two from the agencies dealing with disaster risk

reduction and prevention. The experts from the TAM team led the discussions and after lunch, the four groups reported their findings to the plenary. Subsequently, the rest of the TAM team members gave presentations, focusing on disaster management in China, the use of weather and climate data, early warning systems, awareness raising, capacity building, training and institutional arrangements for disaster management. The day was summarized by Mr. Coen Bussink and Mr. Abrokwah Koranteng from NADMO closed the workshop.



Break-out group discussion during the workshop.

Day 5: 29 November 2013, Friday

In the morning, the TAM team consolidated the observations during the week and a set of preliminary recommendations were put together. Part of the team took the opportunity to conduct another agency visit to the ***Kofi Annan International Peacekeeping Training Center (KA IPTC)***. The center was created 10 years ago and organises trainings and master programmes on peace and security issues. Most of the participants come from police or military.

In the afternoon, a debriefing session was organised where the TAM team presented their findings to the NADMO National Coordinator, NADMO staff and several media houses invited by NADMO. Mr. Coen Bussink gave a presentation on the observations and recommendations from the TAM team.

ANNEX III Geospatial data in policy documents on DRR

The most recent policy document for disaster management is the Ghana Plan of Action for DRR/CCA which was developed in line with the Hyogo Framework of Action 2005-2015.

The plan of action was developed on the base of the National Disaster Management Plan (NADMO and UNDP) that was published in 2010⁷ and that will be updated every 5 years. The NDMP has been prepared to cover both disaster types caused by natural hazards and anthropogenic (man-made) disasters that occur in Ghana. The plan outlines the tasks to be performed by organisations/institutions and individuals for identified disaster types. These tasks cover all aspects of disaster management, namely: prevention, mitigation, preparedness, emergency response, relief and recovery. The NDMP sees a prominent role for GIS and mapping in conducting hazard assessment and vulnerability analysis. However, space-based technology (remote sensing, GPS, communication technology) is not mentioned in this document, neither in the preparedness phase nor in the response and recovery phases.

The NDMP 2010 was accompanied by a National Standard Operating Procedures for Emergency Response, also developed by NADMO and UNDP. The NSOP foresees in the establishment and equipment of Emergency Operations Centres (EOCs) at the National, Regional, District levels and Incident Command Posts (ICPs) in the affected Zones/Communities. This document does not explicitly mention the use of space-based technology either, although communication tools have a prominent place.

In the National Progress Report on the implementation of the Hyogo Framework for Action (2009-2011) published in 2010, the status of several implementation DRR actions are evaluated. In summary, the document mentions that disaster management plans have been prepared for specific regions and districts, however, that the implementation is seriously hampered by lack of adequate funding, ineffective enforcement of disaster related byelaws by the district assemblies and lack of recognition and implementation at all governing levels. Awareness of the benefits of DRR is still lacking at many institutions and communication between the communities and the District Assemblies, NADMO and other lead agencies are not effective. Telephone facilities for reporting on hazards are also almost non-existent and poor accessibility hampers the tracking of vulnerable communities.

⁷ In the same year a National Standard Operating Procedures for Emergency Response was developed by NADMO and UNDP.

There is adequate identification of hazards, constant monitoring and assessment by the Technical Advisory Committees (key stakeholders)⁸. While adequate expertise and equipment for monitoring and early warning exist at the national level, the same cannot be said for the regional, district and community levels. Additionally, capacity to process, analyse and utilise data collected are not very strong at the regional, district and community levels. Negative cultural practices, beliefs and attitudes serve as additional constraints.

Research on multi-risk assessments and cost benefit analysis has been going on at the institutional level, based on the type of hazards they deal with. However, methods and tools for multi risk assessment and cost benefits are yet to be developed.

Context & Constraints: Lack of coordination and commitment. Lack of adequate resources for DRR research.

Lack of funding and logistics are hampering the implementation of the district disaster management and contingency plans across the country. The availability of Disaster Management and contingency plans does not prevail in some districts, communities and institutions, because they do not have the capacity to draw and implement their own plans. (National Progress Report on the implementation of the Hyogo Framework for Action, 2010)

On the basis of the National Disaster Management Plan, a plan of action for Disaster Risk Reduction and Climate Change Adaptation was developed. UNDP with financial support from the Norwegian Government and in collaboration with the National Disaster Management Organization (NADMO) are working on the key components of the Plan of Action.

In the year 2008, a scoping study was commissioned by the United Nations Development Programme to identify priority areas for Ghana to adapt to the impacts of climate change. In this study, establishment of a flood and drought early warning system as well as assessing climate change impacts to the health sector, were identified as top priorities for Ghana.

The results of this study led to the development of the Africa Adaptation Programme (AAP), which focused on EWS and Climate Change and Health project, which focused on the health impacts and adaptation measures in Ghana⁹. AAP was a project funded by the Government

⁸ The identified hazards include: Geological, Hydrometeorological, Fires, Pests & Insects Infestations, Diseases & Epidemics, Nuclear & Radiological, Man-Made (Conflicts, vehicular/boat accidents etc.). In 2007 Hazards Maps were prepared for four hazard types namely: Hydrometeorological, Fires, Pests and Insects Infestation and Geological .

⁹ Funded by Global Environment Facility, managed by UNDP, and implemented by the Ministry of Health. (Source: <http://www.thegef.org/gef/node/3530>)

of Japan to enhance climate change adaptation capacities in 20 countries in Africa with a total budget of US\$ 82 million. From 2010 to 2012, Ghana embarked on a US\$ 2.7 million project under AAP that focused on the establishment of a flood and drought early warning system.

Through AAP, hardware were purchased (8 Automated Weather Stations and 1 High Performance Computer), initial system design was conceptualized for warning communication and information dissemination and young professionals and researchers across disciplines and agencies were brought together to conduct research on how climate change may impact disaster risks at the district and community levels. Furthermore, hazard maps for drought and flood were developed for the five pilot districts of AAP¹⁰ and an indigenous knowledge atlas was compiled to understand what existing local knowledge on weather and climate indicators were available in Ghana. However, despite the initial vision, AAP was unable to finalize the implementation of warning communication.

Building on the initial efforts towards establishing an effective EWS in Ghana through AAP, the Government of Ghana is committed to continuing this work as indicated in Ghana's Plan of Action (2011 – 2015) for Disaster Risk Reduction and Climate Change Adaptation (NADMO, 2012).

In the table below, earlier initiatives by UNDP on disaster management are listed.

Source: UNDP

¹⁰ The 5 AAP Pilot Districts were: Aowin Suaman, Keta, Fanteakwa, Sissala East, and West Mamprusi (Source: AAP Project Management Unit)

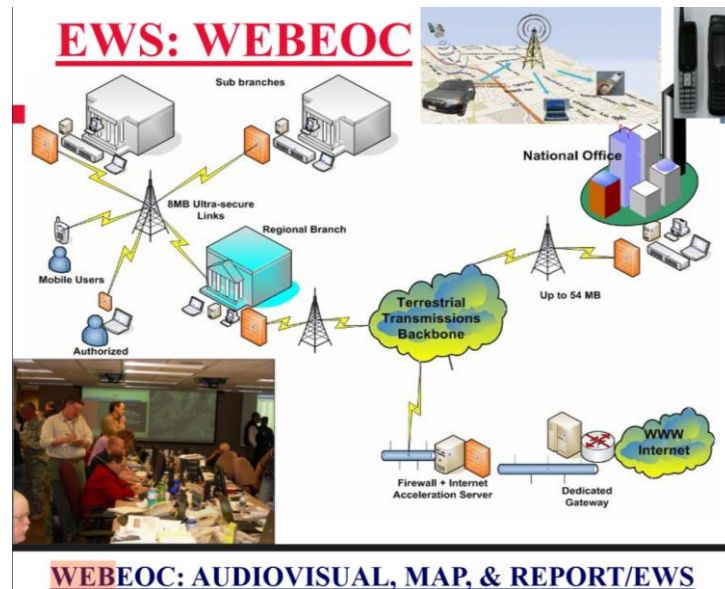
Project Name	Year	Project Focus/ Alignment
Africa Adaptation Programme (Ongoing)	2010 - 2012	<ul style="list-style-type: none"> • Programme objective is to enhance leadership and capacities for climate change adaptation in Ghana • One key focus is initiating the process to establish an early warning system (EWS) for Ghana • Through this effort, AAP has procured 8 AWS and a High Speed Computer • Developed hazard maps in 5 pilot districts • Developed and plot tested EWS warning communication mechanisms
Recovery Project (Completed)	2009-2012	<ul style="list-style-type: none"> • The goal of the project is to strengthen national disaster response/recovery mechanisms in Northern Ghana. • One key focus is restore livelihoods of flood affected communities and build a disaster resilience culture
Institutional Support to integrate DRR into National Development Plans (Ongoing)	2006-2012	<ul style="list-style-type: none"> • UNDP has provided support through annual work plans with the overall objective of reinforcing the institutional capacities of NADMO to better coordinate and implement DRR, preparedness, and response initiatives • Developed a country-wide hazard map
Increased Resilience to Climate Change in Northern Ghana through the Management of Water Resources and Diversification of Livelihoods (The proposal is under consideration by the Adaptation Fund Board)	2013-2017 (Expected)	<ul style="list-style-type: none"> • Main objective is to enhance the resilience and adaptive capacity of rural livelihoods in the northern regions of Ghana to climate impacts and risks on water resources • Focus is anticipatory management of disaster risks
Enhanced Capacity for Coordinated Response to Floods in Northern Ghana (Completed)	2009-2010	<ul style="list-style-type: none"> • Main objective was to strengthen coordinating mechanisms for emergency response to disasters • Supported development of National Contingency Plan
Enhanced capacity for response to floods in Accra (Completed)	2011-2012	<ul style="list-style-type: none"> • Main objective was to enhance the capacity to mobilize local communities and Disaster Volunteer Groups to timely respond to disasters and to create awareness on best practices for disaster prevention

Within the current plan of action, UNDP and NADMO are running a three-year project called CREW (Community Resilience through Early warning System Project), which started in April 2013 with 10 pilot districts. The goals of the project is to build capacities within the country to reduce disaster risks by putting in place an integrated early warning system that is both scientific and people-centered. The outcomes of the project will be used by NADMO to build a National Risk Observatory that will monitor the evolution of hazards and issue appropriate warning to at-risk population, in partnership with the Ghana Meteorological Agency in Ghana (GMet).

The system that is used within the context of the CREW project is WEBEOC, which uses audio-visual material, map and report in planning for EWS. (Inception Workshop Report on

Community Resilience through Early Warning (CREW) Project, April 2013). In 2013, 200 staff members were trained in the use of this tool:

(<http://www.nadmo.gov.gh/index.php/archives/10-main-article/137-nadmo-holds-gis-and-eoc-workshops>). An international consultant is to be contracted for the hazard mapping exercises and oversight of the CREW project.



In 2011, UNU Vice-Rector Prof. Kazuhiko Takeuchi on the record signed agreement with Ghanaian institutions after a two week visit in the West African nation to discuss the framework of CECAR-Africa initiative entitled “Enhancing Resilience to Climate and Ecosystem Changes in Semi-Arid Africa: An Integrated Approach”. CECAR-Africa is a five-year project for climate and ecosystem change adaptation and resilience research involving three thematic areas:

1. Forecast and assessment of climate and ecosystem change impact on agrodiversity
2. Risk assessment of extreme weather hazards and development of adaptive resource management method
3. Implementing capacity development programmes for local residents and professionals

The agreement came in response to request made by the Government of Ghana under the collaborative research programme of the Science and Technology Research Partnership for Sustainable Development (SATREPS) funded by Japan Science and Technology Agency (JST) and the Japan International Cooperation Agency (JICA).

During the visit, a survey team from Japan and their Ghanaian counterparts carried out extensive field surveys in drought and flood affected communities in the three northern regions of Ghana. The two sides held a series of in-depth discussions on the framework of the technical cooperation project.

In order to meet its integrated objectives, CECAR-Africa's implementing institutions shall cooperate with each other. Specific tasks in the three thematic areas would be implemented jointly by University of Tokyo and University of Ghana in theme 1; Kyoto University and Ghana Meteorological Agency in theme 2; United Nations University and University of Development Studies in theme 3.

Source: <http://isp.unu.edu/news/2011/cecar-africa-signed-agreement-with-ghanaian-institutions.html>

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- Engelhardt, F., 2012. Creating an Environmental Geographic Information System for the city of Kumasi, Ghana. Uppsala University. <http://uu.diva-portal.org/smash/get/diva2:575302/FULLTEXT01.pdf> (accessed on 20-03-2014).
- Global Facility for Disaster Reduction and Recovery [GFDRR], 2009. Disaster Risk Management Programmes for Priority Countries. http://www.unisdr.org/files/14757_6thCGDRMProgramsforPriorityCountrye.pdf (accessed on 20-01-2014)
- NADMO, 2010a, unpublished. National Disaster Management Plan. NADMO, Ghana.
- NADMO, 2010b, unpublished. National Standard Operation Procedures for Emergency Response. NADMO, Ghana.
- Owusu-Banahene, W., F. Mensah, S. Coetzee, A.K. Cooper, V. Rautenbach, K.M.Sinvula, E. Nangolo, M. Hippondoka, 2013. A description of spatial data infrastructure stakeholders in Ghana using the ICA model. <http://www.gsdiconf/gsdiconf14/papers/112-Chapter4.pdf> (accessed on 26-02-2014).
- Preventionweb, 2010. Ghana. National progress report on the implementation of the Hyogo Framework for Action (2009-2011). http://www.preventionweb.net/files/15600_gha_NationalHFAProgress_2009-11.pdf (accessed on 26-02-2014).
- United Nations University Institute for Environment and Human Security [UNU-EHS], 2012. World Risk Report 2012. <http://www.ehs.unu.edu/file/get/10487.pdf> (accessed on 14-01-2014).
- Yawson, D.O., F.A. Armah, S.K.N. Dadzie, 2010. Ghana's right to information bill: opportunity for SDI as technical infrastructure. <http://ijdir.jrc.ec.europa.eu/index.php/ijdir/article/download/172/261> (accessed on 20-01-2014).