ICSU Regional Office for Africa

DRAFT SCIENCE / WORK PLAN

NATURAL AND HUMAN-INDUCED HAZARDS AND DISASTERS IN SUB-SAHARAN AFRICA

25 August 2006

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DATE : 25 August 2006
ICSU ROA kindly requests you to submit your feedback electronically, prior to the September Forum. Alternatively, those who will be attending the September Forum will have an opportunity to present their suggestions to the Scoping Groups during the Forum.

Submit your comments to the following:

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PREAMBLE

The International Council for Science (ICSU) is a non-governmental organization with a global membership that includes 107 National Scientific Bodies (19 of which are from sub-Saharan Africa) and 29 International Scientific Unions.

The long-term ICSU strategic vision is for a world where science is used for the benefit of all, excellence in science is valued and scientific knowledge is effectively linked to policy-making.

ICSU’s contribution to strengthening international science for the benefit of society is focused in three overlapping areas:

(i)  **International Research Collaboration** – ICSU plans and coordinates major research programmes in key areas such as, (a) global environmental change; (b) monitoring and observation of the Earth System (c) collection, preservation and dissemination of scientific data and information.

(ii) **Science for policy** – ICSU seeks to ensure that science is integrated into international policy development and that relevant policies take into account both scientific knowledge and the needs of science. Consequently, ICSU represents the science community in important intergovernmental fora, such as, (a) World Summit on Sustainable Development, (b) World Summit on Information Society, (c) UN Commission on Sustainable Development and (d) Earth Observation Summits.

(iii) **The Universality of Science** – The Principle of the Universality of Science is embodied in ICSU’s Statutes: “The practice of science should be equitable and without discrimination.” Thus, the primary aim of ICSU is to enhance the pluralism of science and reach out to all countries, by, (a) ensuring that scientists can freely associate and communicate, (b) providing equitable access to data and information, (c) enabling equitable access to research materials and facilities, (d) building scientific capacity and (e) bringing nations and disciplines together.

The ICSU Regional Office for Africa (ICSU ROA) was inaugurated on 1 September 2005 for the purpose of promoting and coordinating the actives of the ICSU family in sub-Saharan Africa. Such an undertaking will always consider the priorities and the specific realities of this region. In April 2006, the ICSU Regional Committee for Africa (ICSU RCA) selected four priority areas on which its Regional Office would focus its activities in the period between 2006 and 2009 (and beyond). These are: (a) Health and Human Well-being, (b) Sustainable Energy, (c) Natural and Human-induced Hazards and Disasters and (d) Global Change.
In order to address numerous challenges which are embodied in the above mentioned priority areas, ICSU RCA established four Scoping Groups, consisting wholly of African experts, to prepare four science/work plans that would be used to implement, with great success, the objectives of each of the four selected priority areas in sub-Saharan Africa. Terms of Reference (ToR) for this exercise were provided to all the Scoping Groups. They include, reviewing of the current status of each priority area on the African continent, identifying capacity building needs and defining deliverables to be produced to the society. Details on ToR are found at the end of this draft report.

The four draft science/work plans have proposed some lines of action for the realization of the four priority areas in sub-Saharan Africa. It is in this regard that ICSU ROA puts before you the four draft science/work plans for your critical evaluation and constructive suggestions on the improvements to be made on these documents before going into the implementation phase in 2007 and beyond. The reader will find that two or more of the science/work plans have some cross-cutting relationships. This is mostly due to fact the that the four broad subjects are all dealing with the interface between science, society and development. It is in this regard that ICSU ROA strongly believes that appropriate application of science, technology and innovation (STI) in Africa is obligatory for the prudent policy formulation and decision-making on matters pertaining to poverty reduction and accelerated socio-economic development of the continent.

Sospeter Muhongo
25 August 2006
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EXECUTIVE SUMMARY

According to a report submitted at the 28th General Assembly of the International Council for Science (ICSU) in 2005, “Natural and human-induced environmental hazards” are becoming more and more prominent. For example, the frequency of recorded natural disasters rose markedly during the last century from about 100 per decade in the years up to 1940, to nearly 2800 per decade during the 1990s. Africa is the only continent whose share of reported disasters has increased over the past decade. There are several contributory factors to Africa’s high vulnerability to disasters, including the high rate of population growth, food insecurity, high levels of poverty, inappropriate use of natural resources, and failures of policy and institutional frameworks. Despite the huge negative impact that natural and man-made hazards have on Africa’s development, little is done to prevent them. Disaster prevention contributes to lasting improvement in safety, sustainable livelihoods and is essential for the integrated disaster management strategies.

The ICSU Regional Office for Africa (ICSU ROA) Scoping Group on Natural and Human-Induced Hazards and Disasters proposes the establishment of a research, capacity building and outreach programme aimed at reducing the risk of disasters and increasing resilience. The main focus of the proposal is the development of a truly regional and inter-disciplinary approach to the understanding, prediction, assessment and mitigation of hazards and disasters. This is an ambitious undertaking and it needs the collaborative effort of the African scientific community to develop a comprehensive long term institutional and human capacity building initiative that will enable science to benefit society. In particular, it will require:

(i) building strong research and training institutions in Africa at national and regional levels;
(ii) facilitating the exchange of scientific information and sharing of ideas across borders;
(iii) strengthening the link between scientific research and policy making;
(iv) promoting outreach activities to build resilience to disaster risk; and
(v) tapping the knowledge base of rural and urban communities.

ICSU ROA offers the opportunity to bring together existing institutions, appropriate partners (such as universities, scientific institutions, development agencies, humanitarian assistance agencies and NGOs), and policy makers to further develop and build on the activities identified in this strategy. Details of how ICSU ROA intends to achieve these objectives are outlined in this Draft science / work plan.
1. INTRODUCTION

Africa is a continent prone to a wide variety of natural and human-induced hazards and disasters. Phenomena such as floods, hurricanes, earthquakes, tsunamis, drought, wildfires, pest plagues, air and water pollution cause extensive losses to livelihoods and property, and claim many lives. The population of Africa, estimated at 880 million in 2005, is increasing at a rate of 2-4% per annum, so the number of people exposed to environmental hazards and disasters will continue to increase while the measures towards reducing them remain of relatively low priority to decision and policy makers in Africa. Environmental hazards and disasters often pale into insignificance when compared to other pressing issues such as poverty and HIV/AIDS. The fact that 43 African countries are heavily indebted, makes Africa the least equipped and prepared continent to cope with the impacts of hazards and disasters. The reduction of disaster risk through preventative measures is thus a central concern for the sustainable development of Africa. It is highly important that African countries adopt cost effective policy choices to lower risk and allocate appropriate resources for hazard and disaster mitigation.

Africa is, in many ways, the continent that is most in need of scientific knowledge to provide solutions to its socio-economic development. However, the latest developments in science are not often readily available to scientists in Africa. At the same time, investment in science is frequently a low priority for decision and policy makers. Moreover, scientific institutions have relatively weak infrastructures. Thus, whilst current research is largely biased towards the north and its problems, significant societal problems of the south are largely unaddressed.

Through this initiative, the ICSU Regional Office for Africa (ICSU ROA) seeks to revitalise efforts to address the impact of environmental hazards on African communities. It is a major challenge for the African scientific community to develop a truly regional and global partnership to minimise impacts. ICSU ROA’s overall objective is to contribute to improved risk management and to assist in building a culture of prevention, by facilitating the strengthening of public awareness and accessibility to disaster information through joint initiatives with other national, regional and international organisations, governments and civil society, for the sake of sustainable development of Africa.

ICSU ROA proposes to develop both long and short term action plans to implement the strategy. At present, disaster management in Africa is largely limited to emergency humanitarian assistance. In the long term, ICSU ROA aims to mainstream disaster risk reduction practices into knowledge management in order to reduce vulnerability to future
hazards and disasters. Moreover, ICSU ROA will work towards advocacy for incorporation of research findings into policies, and will facilitate planning guides and training activities at all levels in society. However, this requires a multi-disciplinary approach to overcome the limited capacity of scientific research institutions in Africa. Planned short term activities include participation in the hazard-related activities of the International Year of Planet Earth (IYPE) minimising risk, maximising awareness (2007-2009) and the production of a book on “the societal impact of natural and human-induced hazards and disasters in Africa”

2. ENVIRONMENTAL HAZARDS AND DISASTERS IN SUB-SAHARAN AFRICA

A hazard is any event, phenomenon or human activity that may cause loss. Natural and human-induced factors may act together to create a hazard. For example, an earthquake is usually a natural hazard, but may also be triggered by mining activities. A landslide may be caused by a combination of heavy rains, light earth tremors, and deforestation. A disaster is an event that causes a serious disruption, leading to widespread human, material or economic losses beyond the coping capacity of a given society. Disaster management requires a set of actions and processes designed to lessen hazardous events before they become disasters.

The Earth Institute at Columbia University (USA) conducted a project assessing natural disasters and risks to human populations and economic activity to provide a quantitative basis for risk-conscious investments in sustainable development worldwide. The study compiled event data for six natural hazards (Fig. 1). The report notes, “drought and combinations of drought and hydro-meteorological hazards dominate both mortality and economic losses in sub-Saharan Africa” (p. 81). In no other continent does drought appear to be as severe a risk than Africa. The northern countries are regularly threatened by sudden and dramatic events such as hurricanes, floods, etc, but there is great awareness of these hazards and the need to prepare against them. In contrast, most hazards and disasters in Africa (with a few exceptions such as the Mozambique floods of 1999/2000) are relatively silent and insidious encroachments on life and livelihood, increasing social, economic, and environmental vulnerability to even modest events. For example, recurrent drought, deforestation and progressive land degradation, desertification, and HIV/AIDS result in incalculable human, crop, livestock, and environmental losses which are not easily measured by conventional disaster-loss tracking systems. As a result, the calculation of losses caused by a disaster in Africa is often under-estimated. Estimates from western countries usually
reflect insured losses of physical infrastructure where hazards occur in densely populated areas.

Fig. 1

Global Natural Disaster Hotspots

In order to focus on research, the ICSU ROA Scoping Group on Natural and Human-induced Hazards and Disasters divided environmental hazards into five categories, namely, (i) hydro-meteorological, (ii) geological, (iii) biological, (iv) technological, and (v) conflict-related hazards. According to the ICSU terms of reference, warfare and associated activities fall outside the scope of natural and human-induced hazards and disasters. However, this Scoping Group finds it necessary to include conflict-related disasters in the present review, as the numerous internal conflicts, crises and wars impact negatively on Africa’s development. It is the cumulative effect of these hazards that lead to disasters.

2.1 Hydro-meteorological hazards

Hydro-meteorological events give rise to the majority of disasters, impacting nearly every country in sub-Saharan Africa. These include floods, tropical cyclones, storm wave surges, droughts and related disasters (extreme temperatures and forest/scrub fires), sand or dust storms, landslides and avalanches. In the period 1975-2002, disasters of hydro-meteorological origin constituted 59% of the total natural disasters in sub-Saharan Africa, with floods accounting for 27%, drought for 21%, windstorms (particularly tropical cyclones) for 9%, and wildfire accounting for 1%. An alarming feature is the increasing trend in the number of people affected by natural hazards of hydro-meteorological origin in the same period, with drought, flooding and wind storms accounting for 90% of the total number of
people affected. Global climate change will continue to alter the risk associated with hydro-
meteorological hazards. The vulnerability of Africa’s environment is exacerbated by land
degradation, which is a major environmental hazard on the continent.

2.1.1 Flooding and flash floods

Flooding are among the most devastating natural hazards in Africa, and flash floods are one
of the greatest hazards arising from tropical cyclones and severe storms. Floods and flash
floods cause loss of life, damage to property, and promote the spread of diseases such as
malaria, dengue fever, cholera, and chikungunya. From 1900 to 2006, floods in Africa have
affected nearly 40 million people, killed about 19,150 people, and caused damages estimated
at nearly US$ 4 billion. Africa ranks 3rd after Asia and the Americas in frequency of flood
events.

While the primary cause of flooding is abnormally high rainfall (e.g. due to tropical cyclones),
there are many human-induced contributory causes such as: land degradation; deforestation
of catchment areas; increased population density along riverbanks; inadequate land use
planning, zoning, and control of flood plain development; inadequate drainage, particularly in
cities; and inadequate management of discharges from river reservoirs.

The floods that occurred in Mozambique in 2000 are a recent example of a flood disaster.
Rainfall accompanying tropical cyclone Eline caused excessive flows in rivers such as the
Limpopo River with catchments in other countries. These floods affected a total of about 4.5
million people, caused 700 deaths, losses estimated at US$ 500 million, and GDP growth rate
decreased from 10% to 2%. In Ethiopia, the most serious floods occurred in May 1968, August 1994 and May 2005, causing damages estimated at US$ 0.9, 3.5 and 1.2 million,
respectively. The overflow of the Dechatu River in August 2006 killed more than 300 people
and displaced hundreds more.

Flood defence is essential to protect communities. Self help for long term mitigation should be
encouraged. At present, in sub-Saharan Africa, accuracy and lead times of flood forecasts
are limited or questionable. Thus, training and research should stress the prevention of
floods. New research and collaborative efforts are needed to advance flood management in
the future.

2.1.2 Mass movements

Mass movements include a range of natural phenomena including erosion, landslides,
mudflows and siltation. These phenomena are affected by rock and soil types, rainfall
patterns, topography, and vegetation. Human factors that contribute to mass movements
include overpopulation, poor land management, deforestation, and failure to enforce national physical development plans.

Landslides and mudflows cause considerable loss of life and damage to croplands and infrastructure such as highways, railways, and pipelines. Erosion may cause degradation of arable land, with a consequent reduction of agricultural production. Along the East African Rift, the high topography coupled with seasonal rainfall, constitutes the main factor for generation of landslides. For example, in Kenya the El Nino weather phenomenon in 1997-1998 caused widespread landslides and floods in various parts of the country\textsuperscript{20}. The national economic loss due to landslides was estimated at US$ 1 billion. In Réunion, a landslide triggered by heavy rainfall and unstable ground overran a busy coastal road in March 2006. Several vehicles were buried, causing 4 or 5 deaths. A major transport route was destroyed, causing disruption of economic activity. Landslides are also common along the Cameroon Volcanic Line. Most are due to heavy rainfall, although some are triggered by earthquakes. Swarms of over 100 landslides may occur within an area of 5x5 km\textsuperscript{2}. Recent events in Cameroon include the Limbe landslides in 2001 and the Wabane landslides in 2003, where 21 and 23 people were killed, respectively. Heavy economic and infrastructural damage was also caused.

Siltation of rivers and dams results in shallow waters with severe implications on irrigation schemes and consequent reduction in agricultural production as has been the case in Zimbabwe. In Mauritius, deforestation has accelerated erosion. The consequent siltation has a major impact on coastal economic activities such as fishing and tourism.

An inventory of mass movements will be a valuable tool to advance research. These phenomena can be mitigated by stabilising slopes, and enforcing land use planning in vulnerable areas.

2.1.3 Droughts

Although droughts affect most parts of the world, they are a particular concern in sub-Saharan Africa. As a result, emergency food aid to the subcontinent currently accounts for around 50\% of the budget of the World Food Aid Programme in one year\textsuperscript{6}. A large surface area of the sub-Sahara is susceptible to drought, especially in the Sahel with annual rainfall of 150-600 mm, while much of southern Africa, including regions outside the Kalahari, experience frequent drought. The Sahel experienced devastating and prolonged droughts that lasted up to 30 years starting from the 1960s, the causes of which remain a subject of debate. Initial studies blamed the persistence of the drought on land use and the resulting
desertification, but from recent work it appears the 3-decade-long drought might have been
due to complex interactions among the atmosphere, land, and ocean\(^7\)\(^,\)\(^8\). Severe droughts in
southern Africa such as those of 1982–1983 and 1997–1998 have been linked to the El Nino-
Southern Oscillation (ENSO) phenomenon. Nearly all climate change projections signal
greater chances of severe droughts over southern Africa, particularly the central to western
areas\(^9\)\(^,\)\(^10\). Drought is exacerbated by deforestation. For example, deforestation rates in the
Congo Basin Rainforest were estimated at 0.6% per year in the period 1980–1990, while for
the whole of Africa rates vary from 0.1 to 0.7%\(^10\). Loss of tropical rainforest has been linked to
decline in rainfall in regions outside this zone. Deforestation also leads to land degradation
and eventually desertification, thus increasing vulnerability of populations to drought\(^11\). The
most serious result of drought is famine. However, drought and famine are not sudden natural
disasters but rather, the end result of long term degradation of the environment due to poor
land use and deforestation.

The 1970-1974 droughts in the Sahelian region caused unprecedented losses in human life,
livestock and environmental damage. The drought was equally devastating in the Horn of
Africa, and Ethiopia suffered heavily with an estimated 250,000 lives and 50% of livestock lost
in the Tigray and Welo regions. The widespread droughts of 1984-1985 were the most
significant: about 8 million people were affected, 1 million died, and large numbers of livestock
were lost in the Horn of Africa\(^12\). In the 2000 drought, nearly 100,000 people died in the same
region. The most severely affected were the 16 million nomadic pastoralists who straddle the
borderlands between Kenya, Somalia and Ethiopia\(^13\). UNICEF UK (2006) recently reported
that over 8 million people were on the brink of starvation in the Horn of Africa (Kenya,
Djibouti, Ethiopia, Eritrea and Somalia) due to severe drought, crop failure and loss of
livestock\(^13\).

There are a number of organisations that operate to combat drought in sub-Saharan Africa.
The Economic Community of West African States (ECOWAS) is developing programmes in
environment and natural resource management including desertification and water control
management. The South African Development Community (SADC), through its SADC Water
Sector coordinating unit, has approved a strategic approach to manage drought and floods.
The key institutional player is the SADC drought-monitoring Centre in Harare, Zimbabwe. The
SADC Regional Early Warning Unit (REWU) develops information on weather threats,
conditions and drought, and works closely with the African Centre of Meteorological
Application for Development (ACMAD). ACMAD’s mission is to provide weather and climate
information to member countries through weather prediction, climate monitoring, technology
transfer (telecommunications, computing and rural communication) and research. The Inter-
2.1.4 Heat waves

Studies on climate change show that Africa, like the rest of the world, became warmer over the past century and temperatures are expected to continue to rise in the future. Heat waves are predicated to be one of the hazards that will be associated with climate change. Moreover, the problem will be exacerbated by changes in lifestyle linked to urbanisation. There are no statistical records on loss caused by past heat waves in Africa, although various incidents have been reported, for instance, in Botswana. There is a need to study and document the effects of extreme hot temperatures and heat waves on human health in sub-Saharan Africa. In this respect, society needs to be educated and informed on prevention measures e.g. wearing of hats, drinking of water, and energy-efficient architecture (mud and thatch are cooler, but are increasingly being replaced by concrete and corrugated iron sheets).

2.1.5 Fires

Much of sub-Saharan Africa is susceptible to wildfires that destroy pastures, crops, buildings and infrastructure. Wildfires may be ignited naturally by lightning or the spontaneous combustion of coal (Zimbabwe) and peat (Okavango Delta, Lesotho Mountains). However, human beings are responsible for most wildfires. About 168 million hectares burn annually south of the equator, accounting for 37% of the dry biomass burnt globally. For example, it is estimated that more than 60 million hectares are burnt annually in Sudan\(^{16,17}\). This has implications on short term productivity and long term land degradation processes, which eventually contribute to famine during drought periods. Fires caused by human beings are becoming more frequent in Africa. Combined with intense drought, these fires have negative effects on the regeneration capacity of vegetation and on bio-diversity.
Although few deaths are caused by fires, valuable resources are lost, thereby contributing to poverty. Pasture is destroyed, and animals have to be moved or funds allocated to purchase their feed. According to the Africa Air Pollution Information Network (APINA), fire also affects air quality and generates greenhouse gases. Fires can also affect hydrological processes such as run-off and may lead to soil erosion.

Examples of recently reported fire incidents include a threat to fuel storage tanks at an airport in Botswana by a fire during the dry season of 2005; and a wildfire in the Kruger Park, South Africa, that led to the death of ca. 20 people. In Madagascar, fires are used to clear forest for agricultural purposes. In Mauritius, sugar cane fields are burnt prior to mechanised harvesting. These fires sometimes get out of control, causing ecological disaster. In the Borana Zone in Ethiopia, over 32,000 hectares were burnt by 96 fires in March 2000. About 80,000 fire fighters were mobilised to extinguish these fires.

Fire prevention and mitigation requires knowledge on weather, ecology and terrain of the area; infrastructure such as machinery; use of satellite images for monitoring; ability to mobilise and train human resources; and the availability of communication and road networks, all of which are scarce in sub-Saharan Africa. A few African countries, such as Ethiopia and South Africa have fire danger warning systems. However, most research is based on ecological field studies. Recently, the use of satellite data to monitor burnt areas for purposes of estimating biomass-related greenhouses gases has been introduced. The Southern Africa Fire Network (SAFNet) provides a framework for exchange of information and capacity building on fire management with emphasis on use of geo-spatial information technologies. Information provided by the Global Fire Monitoring Centre (GFMC) also covers fires in Africa. In addition, near real time information on active fires detected by the MODIS satellite is provided by the University of Maryland (USA) and NASA.

2.1.6 Tropical cyclones and hurricanes

Weather systems characterised by extreme winds and rainfall, known as tropical cyclones in the Indian Ocean and hurricanes in the Atlantic Ocean, are generated between latitudes 5º to 20º when sea temperatures are sufficiently warm. Cyclones or hurricanes are capable of annihilating coastal areas with sustained winds of 250 km/h or higher, heavy rainfall, and, most devastatingly, storm surges that cause the ocean level to rise by as much as 10 metres. As a cyclone approaches the coast, an 80 to 160 km diameter dome of ocean water sweeps over the coastline, causing coastal flooding and damage to coral reefs, mangroves and fisheries. In most low income countries the mortality rates associated with cyclones are generally 3 to 20 times larger than those associated with floods. Tropical cyclones can cause...
huge economic losses, especially on island states, by damaging dwellings, infrastructure (power, telecommunications, roads) and fisheries. Heavy rainfall can cause floods that damage infrastructure and crops, trigger landslides, and promote disease. The impact of these storms on coastal communities is exacerbated by the destruction of natural barriers such as mangrove swamps.

In sub-Saharan Africa, the areas most frequently affected by cyclones are the Indian Ocean islands and the coastal areas of eastern and southern Africa. Cyclones can penetrate inland as far as Botswana. Countries such as Mauritius are well prepared for cyclones, while countries such as Madagascar, Comoros, and Mozambique are more vulnerable to cyclones. Typically, 12 cyclones occur annually in the south-western Indian Ocean. A very severe cyclone occurs about every 10 years. There is concern that Atlantic Ocean hurricanes could affect West African countries such as Senegal, although there have been no recorded instances of this happening. Further research is needed to ascertain this possibility.

The WMO Regional Specialised Meteorological Centre in Réunion serves the sub-region with information concerning cyclone disasters, especially the members of the South West Indian Cyclone Committee (SWIO). Cyclone warnings are broadcast on radio and television, and published in the press. Warnings are also disseminated through local structures such as schools, religious networks and government and traditional structures. This has made it possible for countries such as Mauritius to reduce the number of people killed by cyclones.

2.1.7 Tornados and hailstorms

Tornados are violent rotating columns of air extending from thunderstorms and are amongst the most violent and destructive of all weather phenomena. Hailstorms are associated with thunderstorm activity caused by intense convection and occur in areas such as the South African highveld, causing damage to property, crops and livestock. The forecasting of tornados and hailstorms is very challenging as they affect very localised areas and last on average less than 30 minutes. Currently, there are no warning systems for tornados and hailstorms anywhere in Africa. Due to their limited impact compared to other hazards, there has been very little research conducted in Africa on hailstorms and tornados.

2.1.8 Dust storms

The Sahel region is one of the largest sources of dust storms in the world. Summer storms from the Sahara kick up millions of tons of dust that alter air quality, affecting animals, plants and the weather. Scientists in the Niger-based Centre de Recherche Médicale et Sanitaire
(CERMES) have found that dust storms blowing across the Sahel might be linked to lethal meningitis outbreaks that often hit this region and its 300 million inhabitants.

2.2 Geological hazards

Currently, disasters due to geological hazards have a far smaller impact on sub-Saharan Africa than those due to hydro-meteorological hazards. Earthquakes account for 2% and landslides and volcanic hazards account for 1% of disasters on the continent. However, the patterns of these hazards may change in future.

2.2.1 Earthquakes

Sub-Saharan Africa is largely a stable intra-plate region characterised by a relatively low level of seismic activity, with earthquakes randomly distributed in space and time (Fig. 2). The only parts of sub-Saharan Africa that do not display the characteristics of an intra-plate region are the East African Rift System and the Cameroon Volcanic Line where earthquakes are associated either with active fault zones or with volcanic activity.

Fig. 2

African seismicity, 1990-2000

Damaging earthquakes with magnitudes of more than 6 (M>6) occur almost annually in the East African Rift. Recent seismic events include the February 2006 Mozambican M7.5 earthquake.
earthquake, which was one of the largest ever recorded in southern Africa and its impact was felt as far as in Zimbabwe and South Africa. Four people were killed, 27 injured and at least 160 buildings damaged. The extent of economic losses was not evaluated. The December 2005, M6.8 event in the Democratic Republic of Congo (DRC) caused several deaths and damaged school buildings. The event also killed a number of people in western Tanzania around the Lake Tanganyika region and left more than 400 families homeless.

The Cameroon Volcanic Line experiences earthquakes associated with either volcanoes or fault movements and these are of limited intensity of up to M6, and have so far not resulted in any human casualties.

Earthquakes also occur occasionally in the Cape Fold Belt of South Africa. The most destructive earthquake that occurred in South African recorded history was a M6.3 event of 29 September 1969 in the Ceres-Tulbagh region of the Western Cape, killing 12 people. Aftershock activity had virtually ceased, when an M5.7 event occurred on 14 April 1970, causing further damage in the towns of Ceres and Wolseley.

The impoundment of reservoirs has also triggered reservoir-induced earthquakes. For example, the filling of Lake Kariba and subsequent fluctuations of water level have been accompanied by seismicity, the largest event having M6.2. Seismicity has also been associated with the Gariep Dam in South Africa and the Katse Dam in Lesotho.

Mining-related seismic events pose a significant hazard to mineworkers in the gold and platinum mining districts of South Africa. Thousands of mineworkers have perished as a result of rock bursting during the last century. No member of the public has suffered fatal or even serious injuries, although some events have caused damage to surface structures. For example, the M5.3 event that occurred on 9 March 2005 near Stilfontein caused serious damage to 3 schools, 2 commercial properties, 3 blocks of flats, the civic centre, and 25 houses.

The existence of a multitude of active faults in the East African Rift system poses significant challenges in terms of their potential causes of hazards and the societal response to frequent earthquakes. Several large dams have been built in the Rift system (e.g. Cahora Bassa, Kariba). However, the capabilities of African research institutions in mitigation of, and response to earthquake hazards are limited. Currently, no earthquake warning in the region comes close to the required level of reliability. A sustainable earthquake disaster mitigation strategy requires compilation of base maps of known faults as well as detection of possible unknown faults. It is also necessary to build interactive databases of high-risk areas and
integrate these with population distribution, seismic history, and vulnerability to hazards and disasters. In order to advance seismic research, it is necessary to develop cooperation among existing institutions and networks such as AfricaArray, a pan-African research and capacity-building programme launched in July 2004. AfricaArray is involved in determining the lithospheric structure of the African Plate, and the chemical and dynamic causes of the African Super Plume, the largest anomaly in the Earth’s mantle, which occurs directly below South Africa.

2.2.2 Tsunamis

Tsunamis, also known as seismic sea waves, are a series of enormous waves created by an underwater disturbance such as an earthquake, landslide, volcanic eruption, or meteorite collision. A tsunami can move hundreds of kilometres per hour in the open ocean and smash onto land masses with waves as high as 30 metres or more. All tsunamis are potentially dangerous, even though they may not damage every coastline they strike. A tsunami can strike anywhere along the African coastline.

The 2004 Indian Ocean earthquake, known as the Sumatra-Andaman earthquake, was an undersea earthquake that occurred at 00:58:53 Coordinated Universal Time (UTC) (07:58:53 local time) on 26 December 2004. The earthquake triggered a series of lethal tsunamis that spread throughout the Indian Ocean, killing large numbers of people and devastating coastal communities across South and South East Asia, including parts of Indonesia, Sri Lanka, India, and Thailand. The number of casualties is estimated at 186,983 dead and 42,883 missing. The impact on coastal fishing communities has been devastating, with high losses of income earners as well as boats and fishing gear. Beyond the heavy toll on human lives, the tsunami caused an enormous environmental impact that will affect the region for many years to come. It has been reported that severe damage has been inflicted on ecosystems such as mangroves, coral reefs, forests, coastal wetlands, vegetation, sand dunes and rock formations, biodiversity and groundwater. This is exacerbated by the spread of solid and liquid waste and industrial chemicals, water pollution and the destruction of sewage collection and treatment systems. Soil and fresh water contamination with infiltrated salt water and salt layer deposits on arable land are also taking their toll.

Although not as severely affected as Asia, African countries also suffered losses (UNESCO, IOC/INF-1219). In Somalia, 176 people were killed, 136 went missing, and 50,000 were displaced. One person drowned in Kenya. In Madagascar, 1,000 people were left homeless. No casualties were reported in Mauritius, but a village in the northern island was submerged.
Three people died and 7 were missing in Seychelles. In Tanzania there were 10 deaths, an oil pipeline was destroyed and an oil tanker ran aground.

The disaster created an awareness of the need for a tsunami warning system for the Indian Ocean. Prior to the event of 26 December 2004, very little research work had been done to address the risk of tsunamis in the region. No historical records of past tsunamis existed for the affected areas. A survey conducted by UNESCO/IOC, WMO and ISDR showed that African countries have very limited capacity to effectively implement mitigation measures for tsunamis. The United Nations started working on an Indian Ocean Tsunami Warning System, and by 2005 had the initial steps in place.

2.2.3 Volcanoes and explosive crater lakes

Active volcanoes in Africa pose a serious threat to life and property. Africa has about 140 volcanoes that have erupted during the last 10,000 years, of which 25 are active (i.e. have erupted during recent historic time ca. 500 years). Volcanic eruptions produce lava and ash flows, pyroclastics, carbon dioxide emissions from volcanic crater lakes, earthquakes, and landslides.

The most disastrous volcanic eruption on record in Africa occurred at Mt Nyirangogo (DRC, January 2002), which killed 147 people and destroyed the Goma, a town with over half a million inhabitants.

The eruption of Mt Karthala (Comoros, April 2006) caused over 10,000 villagers to flee their homes. The volcano is known to erupt in a cycle of approximately 11 years. Previous eruptions caused much damage to crops and pastures.

Other active volcanoes with recent eruptions are Mt Cameroon (Cameroon, 1999 and 2000), Mt Nyamuragira (DRC, 1995 and 2000), Mt Fogo (Cape Verde, 2000), Mt Oldoinyo Lengai (Tanzania, 1994 and 2006) and Mt Fournaise (Réunion) is still active.

The worst recorded disaster from a crater lake eruption occurred in Lake Nyos (Cameroon, 1986) where carbon dioxide emission killed 1,876 people, as well as numerous cattle. A similar event took place in Lake Monoun killing 37 people in 1984.

In order to address the problems related to volcanic hazards, there is a need to acquire remote sensing data (temperature, gases, geodetic, infrared), as well as telemetered monitoring of magnetic and electric fields, gases, temperature, etc. There is an ongoing project by the Royal Museum of Central Africa in Tervuren (Belgium) aimed at studying and
monitoring African active volcanoes (SAMAADV). For this project, radar interferometry is used
to study the recent evolution and assess the risks associated with four active volcanoes, viz.
Mt Nyirangogo, Mt Cameroon, Mt Fogo, and Mt Oldoinyo Lengai. This work is done in
 collaboration with African volcanologists, e.g. University of Buea, Cameroon. However, this
project is limited, as it does not involve extensive ground work.

Africa's preparedness for monitoring of proximal volcanic hazards and for responding to
future disasters is insufficient. Systems have been installed to monitor seismic, thermal and
gas emissions. These need to be complemented with satellite monitoring, GPS and radar
techniques, especially InSAR, for better mitigation strategies.

2.3 Biological hazards

Epidemics and insect infestations account for 36% of all hazards in Africa. In recent decades
the damaging effects of such plagues have become increasingly severe, due to the steady
and continuous population increase.

2.3.1 Disease

Health issues are covered by the Health and Human Well-being Scoping Group. However, the
occurrence of diseases such as malaria, diarrhoeal diseases, chikungunya and dengue fever
are associated with environmental phenomena such as flooding and drought.

Malaria, which is a disease carried by *Anopheles* mosquitoes kills over 1.5 million people in
Africa every year. An African child dies of malaria every 30 seconds. According to the World
Bank reports, the mosquito-borne disease is the leading killer of African children.

Tuberculosis (TB) has been declared an emergency in Africa recently after 46 Ministers of
Health unanimously adopted a resolution at the WHO Africa Regional Committee in Maputo,
Mozambique, on 25 August 2005. There has been a series of cholera outbreaks over the
past 3 to 4 months in Burkina Faso, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger,
Senegal and in the south of the DRC near the eastern border with Rwanda and Burundi.

According to the UN’s Office for the Coordination of Humanitarian Affairs, there have been
24,621 cases of cholera in West Africa this year. Another health disaster in Africa is HIV/AIDS,
which has exacted an enormous toll on the continent. AIDS is now the leading cause of death
in sub-Saharan Africa, having claimed more than 15 million lives in the region since the
beginning of the pandemic. During 2005 an estimated 2.4 million adults and children died as
a result of AIDS in sub-Saharan Africa.
Chikungunya and dengue fever are associated with environmental phenomena such as flooding and drought. In the East African Rift, landslides may cause outbreaks of Valley Fever by releasing a fungus, found in the soil, into the air where it may be inhaled.

2.3.2 Pest infestations

Pests such as locusts, crop eating birds and African army worm cause great agricultural losses, contributing to poverty and famine.

2.4 Technological hazards

2.4.1 Air and water pollution

Air pollution is becoming a serious environmental problem in Africa. The available information suggests that the concentrations of toxic metals in many ecosystems are reaching unprecedented levels. Because of the heavy load of contaminated dusts in the air of highly-populated cities, the ambient concentrations of toxic metals are now among the highest pollutants being reported anywhere. Lead (Pb) pollution from the increasing number of automobiles and cottage industries represents a major health hazard, and it is estimated that 15-30% of the infants in some urban areas may already be suffering from Pb poisoning.

Africa has been experiencing the world’s most rapid rate of urbanization at nearly 5% per annum. This, alongside tax regimes that encourage utilisation of dirty fuels, a sharp rise in the importation of old and outdated cars, and inefficient industrial plants, is increasing levels of air pollution. The high rate of urbanisation (4 to 8% in some cities), expected to be sustained for the next decade, combined with low-income solutions to daily commuting, has resulted in the rapid increase in pollutants emitted by motorised vehicles.

According to the Africa Environment Outlook (AEO) report, the use of biomass fuel, besides degrading the environment, also impacts on the health risks of women and children who mostly do the cooking for the African families. In Tanzania, for example, children under five who die from acute respiratory infections are three times more likely to have been exposed to the burning of such fuels.

To address the issues related to air pollution, a regional network of scientists, policy-makers and non-governmental organisations, known as the Air Pollution Information Network for Africa (APINA), has been established and currently covers the southern Africa region. These activities form part of a Programme on Atmospheric Environment Issues in Developing Countries coordinated by the Stockholm Environment Institute (SEI) and funded by.
Swedish International Development Cooperation Agency (SIDA) under a project entitled “Regional Air Pollution in Developing Countries (RAPIDC).

**Water Pollution** is also a serious hazard in sub-Saharan Africa. In 2000, over 300 million people did not have access to clean and safe water, and over 500 million went without adequate sanitation. Additionally, low-income urban dwellers have to pay high prices for water, sometimes up to 50 times the price paid by higher income groups. This problem has been worsened by a high rate of uncontrolled urbanisation.

### 2.4.2 Gas flaring

Gas flaring is a serious hazard in southern Nigeria. Every day almost 2 million cubic feet of natural gas is burnt during crude oil production, more than any gas flare reported from elsewhere in the world. Gas flaring not only wastes a valuable resource, but is also a major cause of environmental pollution in the Niger River Delta, where most of Nigeria’s oil is produced. According to the World Bank report, gas flared in Nigeria is equivalent to total annual power generation in sub-Saharan Africa (excluding South Africa).

### 2.5 Conflict-induced hazards

Africa is one of the places in the world where ongoing conflicts exacerbate other hazards. Fragile and degraded environments can fuel conflict and war and vice versa. Conflicts exacerbate the effects of natural hazards, such as famine and epidemics, by increasing the vulnerability of societies and ecosystems already under stress. In turn, the type, onset and intensity of conflicts are also influenced by natural hazards, particularly environmental hazards. Both are linked but the relationship is complex. Therefore, these issues need to be integrated in disaster risk reduction interventions. In 1985, almost all drought-affected African countries (e.g., Ethiopia, Sudan, Chad and Mozambique) were also wracked by civil wars. Obviously, in a conflict situation, governments allocate resources to war and put low priority to long-term environmental concerns. Today, landmines and unexploded ordinance affect 30 of Africa’s 54 countries. The severely mine-affected sub-Saharan African countries include: Angola, Chad, Eritrea, Ethiopia, Somalia, Mozambique and Zimbabwe.

### 3. STATUS OF RESEARCH AND IMPLEMENTATION

With a few exceptions, countries in sub-Saharan Africa lack the capacity to conduct research on environmental hazards and disasters, or to apply the knowledge and implement the technologies to mitigate environmental disasters. Compared to the developed world, there is a lack of data, information, and knowledge. Furthermore, there are many other competing
claims to limited resources, and the proportion of GDP devoted to scientific research lags behind the other developing countries. Governments in Africa tend to rely on international donors rather than build indigenous research capacity.

3.1 Resilience and vulnerability of socio-ecological systems

Research is needed on how to transmit knowledge to make communities resilient to disasters. Whereas action today is focused on response and recovery after a hazard event, little research is done on mitigation and prevention. Most of the environmental problems are difficult to solve as they are chronic, diffuse and persistent, and they affect deprived communities disproportionately. Therefore, research on disaster resilience and on how to tap the knowledge base of rural communities to mitigate local vulnerabilities as well as coping capacities is needed. However, indigenous knowledge systems should be verified, validated and standardised as these are often site-specific and cannot be generalised. Traditional knowledge in one region might not be applicable to another region. It is essential to identify best practices for hazard/disaster reduction that can be used as a model for others. In this respect, it is necessary to improve the interaction between local, regional, national and international research teams for the successful exchange of research findings. This requires a multi-disciplinary approach. Many projects have failed in Africa because they are not based on local needs, initiatives and material resources.

3.2 Effective transfer of information to policy makers

There is a need to establish dialogue between scientists, policy and decision makers. As environmental degradation is not only a technical/scientific problem, any discussion of environmental degradation should involve policy and decision makers. Research is needed on how to translate research results into policies that minimise the human and economic cost of hazards; for example, in land use planning and environmental issues. In this respect, ICSU ROA can play an important role in promoting and linking scientific research and capacity building in Africa to policy and decision makers and society.

3.3 Integrated modelling of multiple disasters

A research and implementation plan on natural and human-induced hazards requires an integrated, multi-hazard approach (e.g. environment degradation, conflicts, health hazards) that addresses vulnerability and risk assessment as an integral component of disaster management. Implementation strategy should also provide the scientific scope for the reduction of the risks and consequences of natural and human-induced environmental
hazards. Integrated environmental and socio-economic modelling and scenario building are needed to identify the scale and direction of the necessary mitigating and recovery strategies. In this respect Earth observation satellites are valuable tools for hazards managers and respondents. By using multiple modes of observation, researchers can create methods for integrating information from various sources.

3.4 Early warning and preparedness

There is an urgent need to transmit scientific knowledge on hazards to support early warning and preparedness. The challenge is how to provide relevant education at different levels (communities, schools, tertiary institutions) to facilitate mitigation of hazards. A gender perspective is also essential in disaster risk management policies, plans and decision making processes, including those related to risk assessment, education and training. It is necessary to improve the capability to identify indicators of physical, social, and environmental vulnerabilities throughout Africa and to select and implement realistic solutions to reduce them to acceptable levels. It is also necessary to develop a vulnerability index using hazard maps. This can be used by policy makers to make informed decisions and by donors to provide the required assistance.

3.5 Environmental change

There is consensus among scientists that climate change is a growing threat. However, questions on how climate change will directly impact risk patterns remain largely unanswered because current climate models are unable to predict specific alterations in weather patterns, storm severity, or habitat degradation. Mitigating the unpredictable outcomes of climate change presents a difficult challenge for society at every scale. There is a need to determine how to integrate adaptation to, and preparedness for risks of hazards such as floods, droughts, etc, resulting from climate change.

3.6 Environmental degradation

Long-term environmental problems can fuel conflicts and civil wars. Conflicts and wars can also contribute to environmental degradation. But the interconnections are complex. Research is required on the link between environmental degradation and conflicts.

4. KNOWLEDGE AND TECHNOLOGY GAPS

It is not only enough for the African scientific community to identify the gaps in knowledge; but it requires finding solutions to Africa’s environmental and societal problems. Our review of
recent work on natural and human-induced hazards and disasters indicates that there is a good deal of activity going on in Africa. However, for most countries, there exist gaps in the availability and quality of scientific data and information on natural and human-induced hazards and disasters and often, there is very little sharing of information on this subject. Moreover, historical records are usually inconsistent due to difficulties in establishing and maintaining observation and data management systems. Future prospects need to be understood, and options negotiated.

There is a need to improve training and capacity building to facilitate better use of research results in policy making. For example:

- The quality and availability of historical environmental data (e.g. hydrological) is often very limited.

- Earth Resource Satellites are excellent tools for providing information, e.g., for hydrological studies, catchment physical characteristics such as topography and land use, and catchment variables such as soil moisture and snow cover. However, many countries lack funds, infrastructure, software and skills to download and interpret the data. While low-resolution data is often free (e.g., Landsat, NOAA, Meteosat), it is less accurate, while the more accurate high-resolution data may be very expensive (e.g., SPOT).

- Systems to monitor and forecast river basin floods exist but these are not widely used in Africa.

- There is a shortage of observation platforms that can respond rapidly to disasters e.g. helicopters, airplanes. It is ironic that helicopters are often made available after a disaster has happened, but are not easily procured for monitoring aimed at hazard prediction and disaster prevention.

5. ACTIVITIES AND STRATEGIC PARTNERS

There are a number of organisations and institutions which carry out disaster mitigation in Africa. It is necessary to link and work together with these bodies so that the activities of ICSU ROA complement (not duplicate) existing activities in the region. Some of the institutions which conduct research and capacity building activities are listed below.
5.1 United Nations

The United Nations promotes global sustainable development and poverty reduction through Agenda 21. Reduction in vulnerabilities to disasters is essential to achieve the Millennium Development Goals (MDGs).

The International Strategy for Disaster Reduction (ISDR) which is a successor to the International Decade for Natural Disaster Reduction (IDNDR) provides a global framework for action with the objective of reducing human, social, economic and environmental losses due to natural hazards and related technological and environmental phenomena. ISDR’s role is to encourage both policy and awareness activities by promoting national committees dedicated to disaster reduction and working in close association with regional initiatives. The ISDR Nairobi office launched the Africa Outreach Programme in October 2002 (UN/ISDR Geneva).

The United Nations Environmental Programme (UNEP) puts strong emphasis on the interaction between natural disasters and the environment. Through its Global Environment Outlook (GEO) project, UNEP has carried out scientific assessments on vulnerability to natural disasters for many regions of the world. For example, UNEP assesses the impact of deforestation on vulnerability to natural disasters. It has documented the role of mangroves and coral reefs in protection against the effect of tsunamis in Sri Lanka. Furthermore, UNEP, in collaboration with the global fire monitoring centre, coordinates actions to combat large international forest fire emergencies.

The United Nations Educational, Scientific and Cultural Organisation (UNESCO) is involved in various programmes related to hazards, including the recent International Year of Planet Earth (IYPE) initiative. During the Kobe Conference, UNESCO organised sessions on education for sustainable development, floods and landslides, cultural heritage management, and tsunami mitigation and early warning in the Indian Ocean. It also completed 90 case studies on good practice in disaster reduction.

5.2 African Union

The African Union (AU) seeks to build the resilience of the peoples of Africa to disasters, to support disaster risk reduction and management activities. For example, the OAU, the predecessor of the AU, set up a Special Emergency Assistance Fund in 1984 (SEAF) to help disaster victims.
The New Partnership for Africa’s Development (NEPAD) promotes food security, poverty reduction and sustainable development, as well as actions that seek to reduce the impact of disasters and other threats, particularly concerning the environment, agriculture, and health. Concerning Africa, the Johannesburg plan urged actions at all levels to support Africa to deal effectively with natural disasters and conflicts.

5.3 International Council for Science

The ICSU family has several relevant programs and projects dealing with hazards and disasters. For example:

- The International Geographical Union (IGU) has a number of commissions on hazards and risks. It focuses particularly on vulnerability of ecosystems, such as land degradation and desertification, land use change and population and vulnerability.

- The International Lithosphere Program (ILP) promotes themes that include evaluation of seismic exposure, impact on society, economic consequences, preparedness and emergency response capabilities.

- The projects of the International Union of Geodesy and Geophysics (IUGG) include a series of activities on geohazards, addressing risks in cities intended to explore scientific issues while raising awareness among policy makers.

- The International Union of Geological Sciences (IUGS) program for Environmental Management deals mostly with urban hazards.

ICSU ROA plans to initiate research and capacity development activities in Africa in the framework of the planned IYPE activities. In particular, it is proposed that ICSU ROA mobilises the African scientific community to submit an expression of interest and make a research and outreach proposal under the hazards theme of IYPE - *minimising risk, maximising awareness* (2007-2009). A key component of this initiative will be the development of a research programme through networking with researchers within the Geo-Unions, IGCP, IGOS, IGBP, ISDR, and CDR.
6. BUDGET AND FUND-RAISING STRATEGIES

ICSU ROA will develop proposals for funding in association with the IYPE activities. IYPE aims at sponsoring multi-disciplinary activities. It is also necessary to seek funds from other organisations such as the EU, DFID, and the national and scientific union members of ICSU. SADC, ECOWAS, EAC, etc., have limited financial resources, but could promote project proposals dealing with hazards and disasters. It is also strongly urged that African governments provide financial and material support for these projects.

7. FINDINGS AND RECOMMENDATIONS

The mobilisation of Africa’s intellectual resources will undoubtedly be the critical factor in ensuring implementation of the ICSU ROA science plans for Africa. ICSU ROA can serve as a bridge between African institutions and the international scientific community. In this respect, the need for African scientists to work with local communities in evaluating risks and finding ways to respond to risks cannot be overemphasised. To this end, we would like to make the following recommendations:

1. Conduct education and awareness-raising campaigns that are, as far as possible, directed at all stakeholders at all levels, and using all structures, to ensure understanding of warnings of forthcoming hazards and disasters.

2. This science plan needs the support of African scientific institutions as well as regional and international partners for its successful implementation.

3. ICSU ROA should work to strengthen national, regional and international institutional frameworks to facilitate disaster risk-related information management and sharing.

4. Capacity building and outreach activities on hazards and disasters highlighted in this document should be initiated.

5. A database and tools system for use in prediction and mitigation of hazards, risk reduction and disaster management in the region should be developed.

6. Coordination of different hazard and disaster research initiatives at regional levels should be facilitated.

7. ICSU ROA should ensure the establishment of mechanisms to monitor progress of activities in Africa with regard to hazard preparedness and mitigation.
8. Information regarding research activities (i.e., scientific data, reports and publications) should be disseminated through existing networks such as NEPAD, SADC, ECOWAS, IGAD, SEMAC, IOC, the AU and other pan-African structures. It is also necessary to introduce key research findings into school and tertiary curricula by developing teaching aids, for example, DVDs, CDs, and posters. Centres of Excellence should be supported in efforts to offer specialised courses to practitioners and to involve postgraduate students in research projects.

9. On-line computer-aided interactive learning modules should be developed. For example, case histories with real data and tutorial exercises (an on-line module is being developed by Universities in Mauritius, Malta and South Pacific dealing with vulnerability of islands to natural disasters). The African Virtual University (AVU) in Nairobi is developing teaching materials. UNISA (a South African distance learning institution) offers a module in Disaster Management. The University of Botswana has established “virtual centres” to link scientists working on a particular topic on hazards and disasters.

10. The effect of climate change on various hazards (floods, fire, etc.) should be addressed.
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APPENDIX A

DEFINITION OF TERMS

Source:

Acceptable risk  The level of loss a society or community considers acceptable given existing social, economic, political, cultural, technical and environmental conditions.

   In engineering terms, acceptable risk is also used to assess structural and non-structural measures undertaken to reduce possible damage at a level that does not harm people and property, according to codes or "accepted practice" based, among other issues, on a known probability of hazard.

Capacity  A combination of all the strengths and resources available within a community, society or organisation that can reduce the level of risk, or the effects of a disaster.

   Capacity may include physical, institutional, social or economic means as well as skilled personal or collective attributes such as leadership and management. Capacity may also be described as capability.

Disaster  A serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources.

   A disaster is a function of the risk process. It results from the combination of hazards, conditions of vulnerability and insufficient capacity or measures to reduce the potential negative consequences of risk.

Disaster risk management  The systematic process of using administrative decisions, organisation, operational skills and capacities to implement policies, strategies and coping capacities of the society and communities to lessen the impacts of natural hazards and related environmental and technological disasters. This comprises all forms of activities, including structural and non-structural measures to avoid (prevention) or to limit (mitigation and preparedness) adverse effects of hazards.
<table>
<thead>
<tr>
<th>term</th>
<th>definition</th>
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<tbody>
<tr>
<td>Geological hazard</td>
<td>Natural earth processes or phenomena that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Geomathematical hazard includes internal earth processes or tectonic origin, such as earthquakes, geological fault activity, tsunamis, volcanic activity and emissions as well as external processes such as mass movements: landslides, rockslides, rock falls or avalanches, surfaces collapses, expansive soils and debris or mud flows. Geological hazards can be single, sequential or combined in their origin and effects.</td>
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<tr>
<td>Hazard</td>
<td>A potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Hazards can include latent conditions that may represent future threats and can have different origins: natural (geological, hydrometeorological and biological) or induced by human processes (environmental degradation and technological hazards). Hazards can be single, sequential or combined in their origin and effects. Each hazard is characterised by its location, intensity, frequency and probability.</td>
</tr>
<tr>
<td>Hydrometeorological hazards</td>
<td>Natural processes or phenomena of atmospheric, hydrological or oceanographic nature, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Hydrometeorological hazards include: floods, debris and mud floods; tropical cyclones, storm surges, thunder/hailstorms, rain and wind storms, blizzards and other severe storms; drought, desertification, wildland fires, temperature extremes, sand or dust storms; permafrost and snow or ice avalanches. Hydrometeorological hazards can be single, sequential or combined in their origin and effects.</td>
</tr>
<tr>
<td>Mitigation</td>
<td>Structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards.</td>
</tr>
<tr>
<td>Natural hazards</td>
<td>Natural processes or phenomena occurring in the biosphere that may constitute a damaging event.</td>
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</table>
Natural hazards can be classified by origin namely: geological, hydrometeorological or biological. Hazardous events can vary in magnitude or intensity, frequency, duration, area of extent, speed of onset, spatial dispersion and temporal spacing.

Natural disaster
An extreme event in which a natural hazard interacts with individual and community exposure and vulnerabilities to trigger negative social and economic impacts on a scale that is beyond the coping capacity of the affected population.

Resilience
The capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organising itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures.

Risk
The probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human-induced hazards and vulnerable conditions.

Conventionally risk is expressed by the notation

\[
\text{Risk} = \text{Hazards} \times \text{Vulnerability}
\]

Some disciplines also include the concept of exposure to refer particularly to the physical aspects of vulnerability.

Beyond expressing a possibility of physical harm, it is crucial to recognise that risks are inherent or can be created or exist within social systems. It is important to consider the social contexts in which risks occur and that people therefore do not necessarily share the same perceptions of risk and their underlying causes.

Vulnerability
The conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards.

For positive factors, which increase the ability of people to cope with hazards, see definition of capacity.
Appendix B

ACRONYMS AND ABBREVIATIONS

CDR Committee for Disaster Reduction (ICSU)
CRED Centre for the Epidemiology of Disasters
IAEG International Association for Engineering Geology and the Environment
ICL International Consortium on Landslides
ICSU International Council for Science
IGBP International Geosphere-Biosphere Programme
IGCP International Geoscience Programme
IGOS Integrated Global Observing System
IGU International Geographical Union
IHDP International Human Dimensions Programme
ISDR International Strategy for Disaster Reduction
IUGG International Union of Geodesy and Geophysics
IUGS International Union of Geological Sciences
IUSS International Union of Soil Science
NEPAD New Partnership for Africa’s Development
SCOPE Scientific Committee on Problems of the Environment
UN United Nations
UN-ISDR United Nations International Strategy for Disaster Reduction
UNESCO United Nations Educational, Scientific and Cultural Organisation
UNEP United Nations Environment Programme
USGS United States Geological Survey
WCDR World Conference on Disaster Reduction
WMO World Meteorological Organisation.
APPENDIX C

TERMS OF REFERENCE

Scientific Planning Groups of the ICSU Regional Office for Africa

Based on the ICSU Strategic Plan 2006-2011, the ICSU Regional Committee for Africa has selected four priority areas for its activities in the period between 2006 and 2009. These are: (a) Health and Human Well-being; (b) Sustainable Energy; (c) Natural and Human-Induced Environmental Hazards and Disasters, and (d) Global Change.

Each priority area will have one Scientific Planning Group, which may need to meet three times: a first meeting to prepare a preliminary report, a second meeting during the Second Consultative Meeting in September and a third time to finalise the report. The generic Terms of Reference (ToR) for the working groups are as follows:

**GENERAL TERMS OF REFERENCE**

1. To briefly review the current status of the priority area in the sub-Saharan Africa. This will include taking stock of the major R&D&I activities (i.e. ongoing and planned) of the priority area in the sub-Saharan Africa. Interests of the ICSU Scientific Unions, Interdisciplinary Bodies and Joint Initiatives should be incorporated in this exercise.

2. To formulate a set of detailed objectives for the priority area based on the ICSU Strategic Plan of 2006-11 taking note of past and ongoing planning efforts by ICSU internationally.

3. To make proposals on targeted areas of research in the given time frame, and define milestones that should be reached during the life span of the proposed programme of the priority area.

4. To define capacity building needs.

5. To define deliverables which they will produce to the society.

6. To propose ways by which the ICSU family and its strategic partners can be involved in implementing the proposed actions.

7. To identify ways by which the results of the research can be made available to policy makers and other stakeholders in the region.

8. To propose a budget for the activities of the programme(s) of the priority area, define fund-raising strategies and possible funding sources.

9. To propose a mechanism for guidance and oversight of the programmes/projects of the priority area, including the assurance that the activities of the Regional Office are complementary to (not duplicating) the existing activities in the Region.

10. To submit a preliminary report to the ICSU Regional Committee for Africa by 30 June 2006 and a final report before the end of 2006.

**SPECIFIC TERMS OF REFERENCE FOR NATURAL AND HUMAN-INDUCED HAZARDS AND DISASTERS**

To propose a process whereby the African planning can feed into, and influence the international planning effort, taking particular note of how the proposed activities can contribute to the Geohazards theme of the International Year of Planet Earth (IYPE)
ICSU ROA kindly requests you to submit your feedback electronically, prior to the September Forum. Alternatively, those who will be attending the September Forum will have an opportunity to present their suggestions to the Scoping Groups during the Forum.

Submit your comments to the following:

<table>
<thead>
<tr>
<th>Priority Area</th>
<th>ICSU ROA contact person</th>
<th>Email address</th>
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</thead>
<tbody>
<tr>
<td>Sustainable Energy</td>
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</tr>
</tbody>
</table>

*All correspondence concerning this priority area should be addressed to: Achuo Enow (e-mail: a.enow@icsu-africa.org)