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1. INTRODUCTION

THORPEX (Shapiro and Thorpe , 2004; Rogers et al. 2005) is a significant World Meteorological Organization (WMO) contribution to reduce the effects of natural disasters and realize societal, economic and environmental benefits. This contribution will be possible through accelerated improvements in one-day to two weeks high impact weather forecasts. The recent advances in forecasting science, information and telecommunication technology, computing capabilities provide the impetus for THORPEX particularly for developing countries. More importantly, the expected increases in frequency and severity of weather events (IPCC 2001, 2007) make improvement in high impact weather forecast information a priority endeavor.

THORPEX Africa is the regional component of the International THORPEX program. An important aspect considered in the development of Thorpex Africa plan is the emphasis on how the plan meets the needs of African society, economy and environment and build on existing national, regional and global initiatives. WMO supported the organization of two planning meetings in the THORPEX Africa plan development process. The first planning meeting held in February 2007 in Ouagadougou (Burkina Faso) reviewed a first draft THORPEX Africa science and implementation plan and set up two task forces to revise the plan and propose an organizational structure to oversee and coordinate THORPEX Africa. The second planning meeting held in Karlsruhe (Germany) in November 2007 finalized the science plan, agreed on priority activities for which an implementation plan will be completed during the first half of 2008. A regional Committee for Thorpex Africa was established.

This paper presents the challenges and progress

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made towards developing the Thorpex Africa science and implementation plans. It describes the goal and objectives of the plan and summarizes the objectives and achievements of Thorpex Africa planning meetings. Collaborations with international programs and organizations to improve high impact weather monitoring, forecasting and applications for sustainable development in Africa are proposed. Some steps towards a strategy for effective implementation of Thorpex Africa activities are discussed.

2. CHALLENGES OF THORPEX AFRICA

Reduction in annual growth rate (from 8% to 2.1%) in Mozambique (World bank, 2001), reduction in hydroelectric potentials of countries like Kenya leading to emergency loan (World Bank 2000) are becoming frequent in Africa. There is a growing evidence that high impact weather and climate events frequency or severity will continue to increase with a changing climate (IPCC, 2007). Many countries in Africa are developing nations with some among the least developed countries with high vulnerability to natural disasters. Preparedness, response and recovery in case of high impact weather in Africa is a challenge because:

- current investment on high impact weather observing systems is very low;
- vulnerability of Africa is among the highest in the world;
- use of communication and information technology is limited making high impact weather data and information unavailable for all communities on time;
- Monitoring forecasting systems performances over Africa is not regular making forecasts and early warnings highly uncertain;
- Extra tropical interactions and transitions, equatorially trapped and tropical waves modulate in a complex manner many African high impact weather events.

The International THORPEX program provides a strong base on which Thorpex Africa address these challenges by capitalizing on the facilities and networks put in place by WMO. Strategic partnership among African research, operational and user communities will be formalized at national, sub regional and regional levels to optimally use existing institutions, infrastructure and human resources.

3. THORPEX AFRICA GOAL AND OBJECTIVES

The THORPEX Africa primary goal is to improve one-day to two weeks high impact weather forecast and applications for the benefits of African society, economy and environment. The major objectives of THORPEX Africa are to:

- promote optimal low cost observing and telecommunication system for Africa (AMDAR, GPS, radio sonde, A-train constellation...);
- improve understanding and modeling of processes and phenomena associated to African high impact weather ;
- assess and improve predictability of high impact weather;
- encourage and coordinate capacity building and infrastructure development to collect, control, assess, archive, process and analyze high impact weather data for research , prediction and applications;
- carry out forecast demonstration experiments to prove the performance and practical additional benefits achieved through decisions based on forecast information in key sectors (aviation, water and disaster management, agriculture, energy production and distribution, health and fishery);
- promote development and test of seamless forecasting systems to provide forecasts information from daily to seasonal timescales in collaboration with WCRP/CLIVAR for Africa and WCP/CLIPS;
- capitalize on advances in information and communication technology to build a high impact weather information system for Africa containing observed and predicted meteorological data, estimates of economic, societal and environmental losses (damages to property, crop and infrastructure, displaced people,...), success stories on the applications of forecasts information for decision and policy making.

4. PLANNING MEETINGS OBJECTIVES AND ACHIEVEMENTS

The First THORPEX Africa planning meeting held in Ouagadougou (Burkina Faso) from February 10 to 12, 2007 reviewed and discussed a draft THORPEX plan for Africa developed within the WMO Atmospheric Research and Environment Program Department with the support of African institutions. A THORPEX Africa network of institutions and experts was constructed to facilitate exchanges and interactions necessary to further development and implementation of THORPEX activities (Fig.1) . A first task force was set up to prepare a revised THORPEX Africa plan following the review of the draft plan. A second task force was created to prepare an organizational structure to oversee, coordinate THORPEX Africa activities and liaise with international programs. A presentation of the meeting outcomes was made to the Regional Association 1 pre-conference that followed a few days later to raise awareness of African Meteorological Services on THORPEX activities for Africa. Collaborations with University Corporation for Atmospheric Research (UCAR) Africa initiative, UNESCO/ICTP weather and climate program and its African network of affiliated centers and associate scientists were extensively discussed and considered as a foundation for further development and implementation of THORPEX Africa research activities. Formal arrangements between THORPEX Africa, UCAR and UNESCO/ICTP were proposed to provide a framework needed to undertake activities that meet THORPEX Africa objectives mentioned above. It was stressed that achieving successful forecast demonstration experiments and realizing societal and economic benefits with THORPEX Africa work are essential to build trust and facilitate further investments in capacity building and infrastructure development in Africa.

A second THORPEX Africa planning meeting was held in Karlsruhe (Germany) from November 23 to 24, 2007 to:

- present the revised THORPEX Africa science plan and priority activities prepared by the first Task Force;
- make comments and suggestions to finalize the science plan;
- discuss top priority activities and related partnerships, networking, feasibility, timeline and resource mobilization to facilitate the implementation plan development;
- discuss opportunities to advertise the plan;
- review the organizational structure based on the second task force propositions and discuss some activities of THORPEX Africa regional committee for 2008 and 2009.

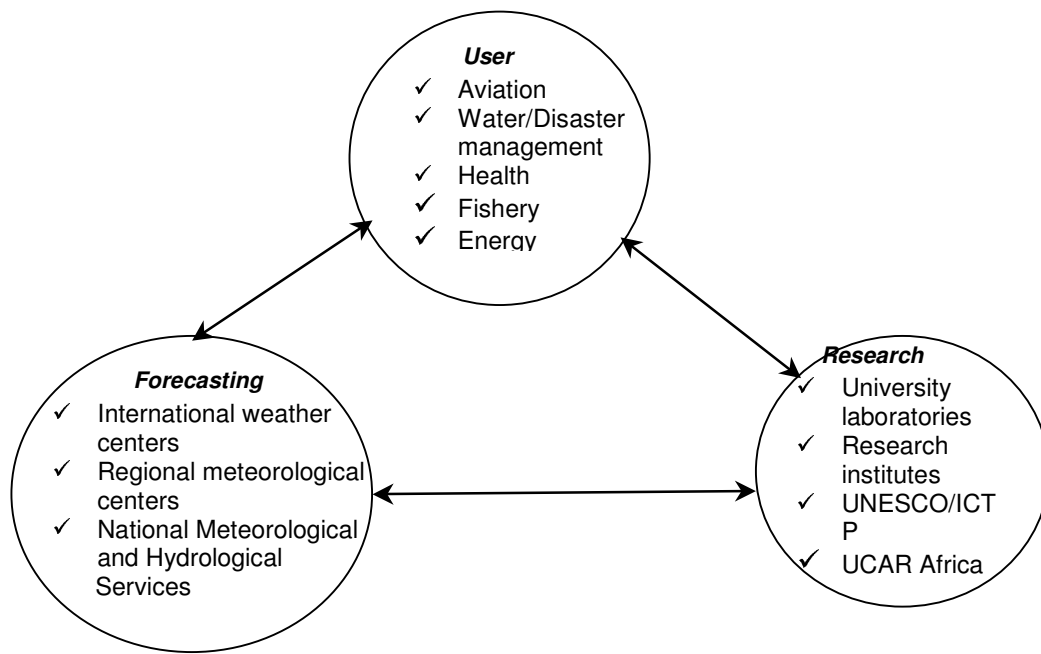


Figure 1: Schematic describing operational, research and user communities. MoUs and other formal working arrangements will be promoted between these communities at national and regional levels.

The THORPEX Africa community and international partners reached a consensus on the science plan presented. The following subcomponents constitute the science plan:

- the observing system, data assimilation and observing strategy;
- processes and predictability studies,
- societal and economic research applications
- Cross-cutting tasks and collaborations.

A review of priority activities proposed by the first task force led to identification of the following feasible activities for different sub components.

Observing system, data assimilation and observing strategy.

Assessments will be made of impacts on forecasts and potential benefits of improvements on the West African observing system particularly the radiosonde network and dropsondes deployed in the framework of AMMA observing campaign (Redelsperger et al., 2006). THORPEX Africa will extend these assessments over African regions outside the monsoon area with special focus on high impact weather. A project is being developed to maintain parts of AMMA radiosonde network for data impact studies.

Deployment and test of AMDAR, GPS and satellite data for real time monitoring and forecasting of high impact weather will be pursued. Substantial support is expected from the AMESD project funded by the European Commission for a better use of METEOSAT Second Generation data and

products for African high impact weather monitoring. Historical data on high impact weather will be collected, controlled and archived as a contribution to high impact weather information system. THORPEX Africa will build project proposals on initiatives already underway involving, AMMA, data rescue, WMO AMDAR panel, the South African Weather Services and the Agency for Safety of Air Navigation in Africa and Madagascar (ASECNA). Africa is recognized as a major source of aerosols found in the atmosphere. Advanced data assimilation algorithms to enhance the use of satellite or other new observing platforms data and particularly remotely sensed aerosols data are considered important to improve analyses and forecasts of some African high impact weather. Joint activities will be discussed with CLIMDEV Africa interested by improvements in the observing network for climate monitoring and forecasting. These studies will guide decisions to establish an improved, low cost and optimal observing network for Africa building on and working with AMMA over the monsoon region of Africa.

Process studies.

High impact weather in Africa is influenced by global/regional processes and phenomena (ENSO, MJO, NAO, AAO, equatorially trapped, tropical and extra tropical waves, variability of deep convection and circulation in the ITCZ). Better representation of these processes is necessary to improve high impact weather predictions. Studies to improve understanding and development of conceptual models describing these processes and related interactions for genesis, development and decay of high impact weather is proposed in a partnership between forecasting and

academic communities (Fig.1). Additional features or parameters to better identify and make an inventory of high impact weather will be investigated. A synthesis of previous work on African high impact weather process studies will guide activities mentioned above.

Predictability studies.

Extra tropical regions of Africa rely on forecasting systems performance monitoring developed by international weather centers for mid latitude and polar regions. Thorpex Africa will collaborate with MEDEX and SH THORPEX to monitor forecasting systems for northern and southern Africa high impact weather. Performance monitoring systems under development in the framework of AMMA-THORPEX working group will continue and expand over all tropical Africa with the support of international weather centers. More importantly, THORPEX Africa will evaluate prediction systems (deterministic and ensembles) for high impact weather at short, medium and extended range. Recent research and forecasting experience are suggesting that there is substantial potential skill in forecasting weekly anomalies one to two weeks ahead (Winkler et al. 2001, Mathews 2004). Additional predictability studies are expected to confirm these results for high impact weather in Africa. Identifying strengths and weaknesses in forecasting systems, estimating forecasts uncertainties, assessing predictability limits and developing existing limited area modeling capabilities in Africa are additional essential activities on predictability of African high impact weather.

Societal, Economic Research and Applications

Forecast information benefits society through its use in policy and decision making. Direct models outputs are processed to provide tailored information using application tools. In Africa, substantial effort is still required to develop and test application tools that add value to weather information for decision making. It is indicated that pilot forecasts demonstrations experiments with the use of Ensemble Prediction Systems (EPS), high resolution deterministic forecast products at short and medium range, monthly and seasonal forecasts are essential. Demonstrations will help to build and use training/education materials for forecasters and users, test and standardize new forecasting methods, techniques and procedures, verify forecasts data and information, better identify users needs. WMO congress in 2007 encouraged forecasts demonstration experiments with up to date technology and tools because of the demonstrated

benefits particularly to developing countries. Thorpex Africa will capitalize on successful achievements of the Severe Weather Forecasts Demonstration Project in Southern Africa led by South African Weather Services (SAWS) and implement a pilot forecast demonstration for West and central Africa in 2008. Similar pilot initiatives will be prepared for East and North Africa. The SAWS will continue to lead forecast demonstrations for southern Africa. The priority user sectors for demonstration are disaster and water management, transportation (particularly aviation), energy production and distribution, agriculture, health and fishery. The international partnership established for the Southern Africa forecast demonstration will be mobilized for all Africa forecast demonstrations. Better communication of forecast uncertainties, specific user relevant verifications, assessments of cost and benefits of forecast improvements, training, forecasts and impacts database for all priority sectors are initiatives expected to improve the utility of high impact weather forecasts. Strong partnerships (Fig.1) involving science, operations and user communities will be crucial for success.

Cross-cutting activities and collaborations

Advanced information and communication technology provides an opportunity for Africa. THORPEX Africa will use these facilities to build an African High impact weather information system. MEDEX and SH THORPEX databases will form the initial content of the information system. An all Africa inventory of high impact weather and related parameters, societal, environmental and economic impacts data, documentation on accuracy, skill, strengths and weaknesses of high impact weather monitoring and forecasting tools, training and education materials on African high impact weather, best practices, success stories, standards, procedures, publications and reports are additional components of the information system. TIGGE, NAEFS and related network of forecasting centers, AMMA-THORPEX working group activities are important opportunities of collaborations that THORPEX Africa will promote.

Infrastructure development and capacity building in Africa are considered crucial for sustainability of all THORPEX Africa initiatives. National and regional institutional, technological and networking capacity to collect, control, archive, process, analyze and exchange high impact weather data and information for the selected key sectors mentioned above will be promoted in collaboration with ongoing initiatives. WMO, UNESCO/ICTP, UCAR Africa initiative and the Third World Academy of Sciences (TWAS) will be the main partners of THORPEX Africa in this regard. Web based learning platforms like the Cooperative program for Operational Meteorology, Education and Training (COMET), manuals, procedures and guidelines, training

materials and best practices will be developed or expanded for capacity building.



Fig.2: Multiscale organization facilitating coordination from global to national levels.

5. SOME THORPEX AFRICA IMPLEMENTATION REALITIES AND EXPECTED BENEFITS

Given the challenges mentioned above, implementation of THORPEX Africa relies on ongoing initiatives, opportunities available with information and communication technology, incremental developments of activities given the successes of pilot actions.

The information system will consist of computer based platforms with high impact weather relevant data for decision makers, scientists, forecasters and users. Successful experiences with the development of AMMA, MEDEX and SH THORPEX data bases are the basic motivation together with the internet facilities. To ensure rapid exchange of data and information, THORPEX Africa will promote development of national/regional networks of individuals and institutions (Fig.2) interested by high impact weather information production, dissemination and use. National network coordination mechanisms will be established following THORPEX principles. The networking approach will begin by building the network of experts, followed by a network of institutions at national and regional levels. Existing information and communication technology and particularly internet are opportunities to facilitate multiscale networking for education, training, review, assessment, monitoring and timely information exchange. Sub-regional economic groupings for North, West, Central, East and southern Africa will be leading institutions in THORPEX Africa sub regional networks.

THORPEX Africa recognizes the importance of extensive exploitation of existing forecasting systems to improve or tailor high impact weather information. Over Southern Africa, disaster managers confirmed that the past year severe weather forecasts demonstration provided benefits with improved early warnings. The South African

Development Community member countries are committed to transfer forecasts demonstration achievements to operations during the coming years. THORPEX Africa will run a similar pilot demonstration experiment in West and Central Africa in 2008 and support development of other demonstration plans for East and North Africa.

A pilot forecast demonstration will consist of a one week training on Ensemble Prediction Systems and new diagnostics tools followed by experimental real time forecasting during a season. The deliverables include experimental production of expected high impact weather bulletins at short/medium range, weekly and seasonal outlooks, verification of forecasts data and information using metrics and surveys, production of high impact weather reports.

Thorpex Africa will build on experience in Observing systems and strategy, process studies from AMMA, data assimilation capabilities of global weather centers, limited area modeling initiatives in African Meteorological services and research institutes, results from MEDEX phase I on the climatology of North African high impact weather, successful southern Africa experience in SH THORPEX and severe weather forecasts demonstrations. The benefits expected from Thorpex Africa are:

- reduction in losses and damages due to high impact weather in Africa;
- enhanced networks and infrastructure for high impact weather data or information collection, control, archiving and exchange;
- rapid sharing of information with development of information and communication technology;
- increased number of meteorologically informed decisions and policies;
- increased quantity of high impact weather data collected, controlled, archived and exchanged in Africa;
- increased number of scientists, forecasters and users exchanging high impact weather data and information;

- Increased number of disaster managers using improved watches and warnings.

THORPEX Africa will be implemented under the global leadership of WMO and the oversight of the Regional committee for Africa.

6. SUMMARY AND CONCLUDING REMARKS

The THORPEX Africa planning meetings achieved their main objectives: they a) brought together participants from research, forecasting and user communities within and outside Africa to exchange ideas, learn from each other on THORPEX goals, objectives, principles and plans at global and regional levels; b) contributed to discuss, review and reach consensus on THORPEX Africa science plan based on sound scientific principles; c) facilitated establishment of strong partnerships between participating experts and institutions; d) promoted THORPEX Africa initiatives in international collaborating centers; e) helped to finalize THORPEX Africa science plan and pave the way for rapid development of the implementation plan during the first half of 2008.

As the world leading organization for THORPEX, WMO will continue promoting international partnerships to tackle high impact weather forecasting, societal and economic challenges. THORPEX Africa as the regional component of the International THORPEX program offers a great opportunity to review Africa's international cooperation in meteorology articulating on improving high impact weather forecasts and realizing benefits for users, reaching out a wider research community outside operational centers in Africa, formalizing working agreements at national, sub regional and regional levels between science, operational and user communities (Fig.2) to tackle THORPEX Africa challenges. The five African sub regional economic groupings are leading institutions to promote national networks for THORPEX Africa initiatives. THORPEX Africa strategy relies on incremental development of activities starting with ongoing initiatives and pilot projects. It will progressively demonstrate forecast improvements and benefits raising the profile of national networks and gaining commitments from governments and the private sector. This approach requires provision of operational data for the research community, regular discussions and meetings, exchanges, working visits, workshops between research, operations and user communities. TIGGE, NAEFS and the Global Interactive Forecast System, THORPEX regional and global campaigns, AMMA, MEDEX, SH THORPEX, the Year Of Tropical

Convection, UCAR Africa, UNESCO/ICTP are regional and global initiatives on which THORPEX Africa will grow.

7. ACKNOWLEDGEMENTS

The THORPEX Africa Task Force thanks the WMO and member countries for their support during the planning process. The authors acknowledge the guidance of Dr. Jim Caughey of the THORPEX International Project Office at WMO and the assistance of all colleagues of the International THORPEX program.

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