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MapClim System : Early warning mechanisms to climate change in Africa

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Abstract. This work is carried out within the framework of the implementation of innovative technological applications to facilitate the resolution of development issues raised by climate changes. It describes the architecture used for the design of MapClim, a free system of access intended for the collection, systematic monitoring and diffusion of the data with the creation of capacities of community and national answer. Thus, it enables to establish a permanent waking state and to take fast and efficient actions in favour of the adaptation to the climate change. Our article, in the light of data, indicators and process charts, presents the results on the effects of the climate change in West Africa.

Keywords: Development, climate changes, information system, e-service.

1 Introduction

Now, climate change is undoubtedly a global concern that requires real solutions, especially, as their causes and impacts on the environment and human health are better understood [1]. That is why our research team has developed MapClim; it is a system of early warning mechanisms to climate change so as to support a dynamic approach in West Africa. Ultimately, that system will enable to get results in the environmental and socioeconomic level, in favour of populations of the fifteen (15) countries of the region. That is the western part of sub-Saharan Africa with the diverse nature of the climate and vulnerabilities peculiar to the region, make worse the consequences of climate change. MapClim is therefore, a product of our researches, designed to strengthen the fight against climate change by using an approach based on : data collection related to indicators of climate change from the community level, the analysis of collected data through a visualization module and

the interpretation of results. All this, to take adequate measures as preventive actions. The analysis and the interpretation are based on global data collected on Climate Change since 1960 until today and may take into account in the future, data collected locally, for a wise use. Our system enables experienced and inexperienced users to have access to information as texts, figures and illustrations (images, sounds, videos and graphics) and to be able to understand and to take action, whatever their level or disadvantage.

2 Material

2.1 Research framework

Climate change is a long-term modification of general weather conditions. It is measured by changes in temperature, rainfalls, wind, snow and other indicators [2]. According to the World Bank, developing countries will be the most affected by climate change. Among its many effects, let us cite : rising temperatures, disruption of rainfall patterns, rising sea levels, increasing frequency of weather disasters that threaten agriculture, food, water supply, health and the achievement of the Millennium Development Goals. In order to monitor these situations, the World Bank has made available a database registered for several years and that deals with the climate system, the exposure of countries to the effects of climate change and their resilience, greenhouse gas emissions and energy consumption [1] [4].

Our research has focused on the potential contribution of the Communication and Information Technology for Development (CiT4Dev) for an optimum use of those data. The main objective of the project CiT4Dev, is to develop innovative applications that actors from developing countries can use to take certain actions. This project is based primarily on global data available to scientists to solve development problems. In this paper, we deal with the indicators issue on climate change so as to promote the innovative use of this information and create applications that can cope with various stakes of climate change in relation to development. Implemented applications must enable the establishment of effective mechanisms for early warning based on populations, for understanding and managing natural disasters in West Africa. That part of Africa will serve as a testing ground for our system. It has a geographical and cultural variety between the Atlantic Ocean to the west and the south, the Sahara in the north, and approximately the 10th meridian east [3]. As part of our research, our work will cover the 15 constituent countries of the region (Benin, Burkina Faso, Cape Verde, Ivory Coast, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo) Fig. 1.

Fig. 1. West Africa

2.2 Early warning system based on population

Early warning is an essential element in preventing disaster risks. It helps to avoid or to stop loss of human lives and to reduce the physical and economic impact of disasters. To be efficient, early warning systems must actively involve communities at risk. They must also facilitate public education and awareness, spread messages and warnings with efficiency and make sure to maintain a waking state and constant preparation. The four main elements of early warning systems based on population is shown in Fig. 2. [7].

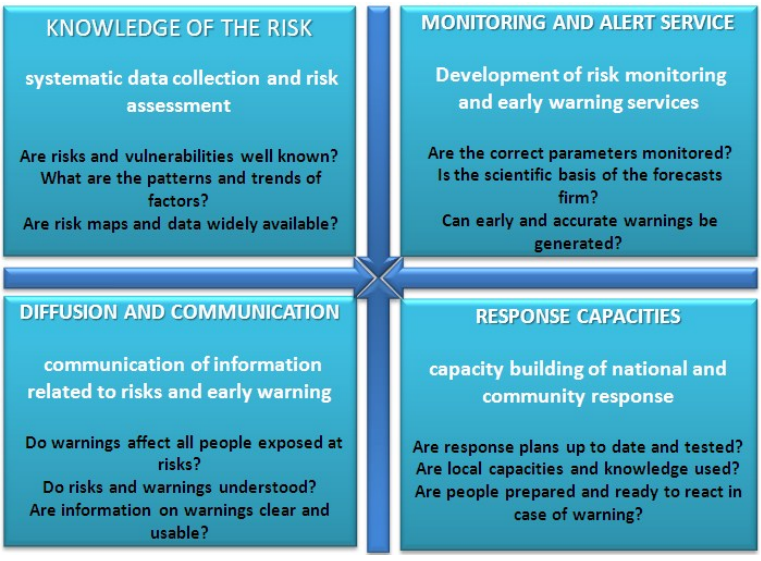

Fig. 2. Main elements of early warning systems based on population

3 Method

To achieve our goals of establishing an early warning mechanism to climate change in West Africa, we will : (1) consider existing facts. In other words, we will analyze all available data , documents and information since 1960 until today, (2) propose a coherent data model that meets the requirements (collection, analysis and interpretation) and enables monitoring, information or communication and capacity building Community and national response from towns and villages, (3) an implementation of applications that will be the MapClim system. Fig. 3. describes

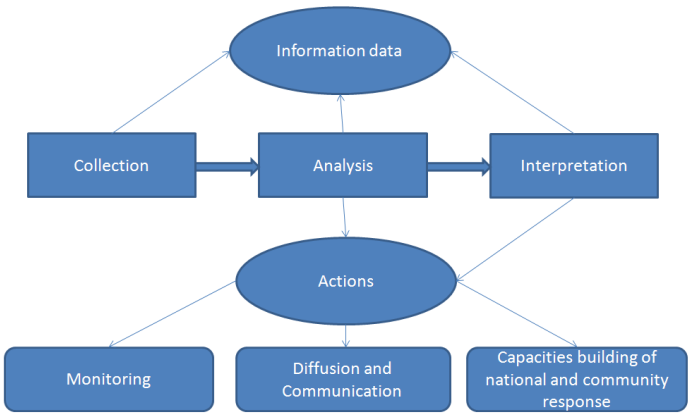

Fig. 3. Basic model of the MapClim system

3.1. Existing data models

Our analysis is based on existing data from three main sources. (1) Data indicators for development, compiled officially and based on accepted international sources. They present the latest and most accurate data of global development available, and include national, regional and global estimates. Fig 4 shows this type of data model. (2) Data on climate change and knowledge portal on climate systems, exposure to the impacts of climate change, resilience, greenhouse gas emissions, energy use and data on water, as well as data available here and through the Climate Data API, then the knowledge portal on climate change that has a web interface [1] [3]. The portal also offers a collection of water indicators that can be used to assess the impact of climate change through more than 8000 water basins worldwide. (3) Knowledge Portal on climate change: data projections on temperature and rainfalls from multiple models, aggregated at the countries level during months and years in four future periods [5] [6].

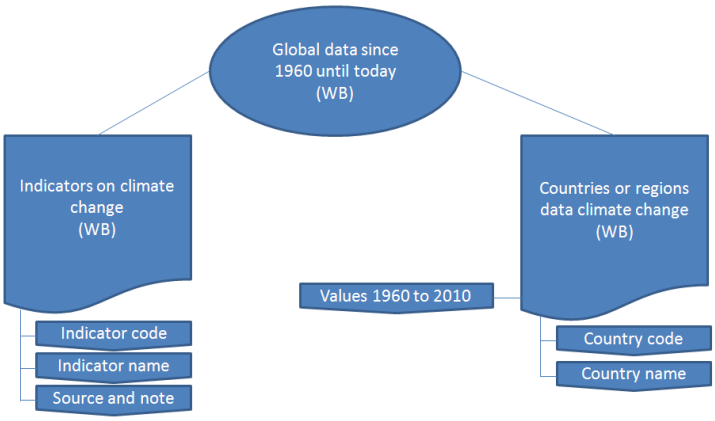

Fig. 4. Existing data model

3.2. Existing metadata

Metadata used in our study are composed of several structured data : "Indicators", "Series", "Country", "Data related to indicators from 1960 to 2011", "Basins and Countries for Temperatures and Precipitation , "" projections and changes in temperatures and precipitations from 2020 to 2100 ". These data are on more than 50 columns and hundreds of thousands of lines. Fig. 5. shows an example of those existing data structures.
Those data are stored as Excel, XML and CVS files. They are also accessible via APIs

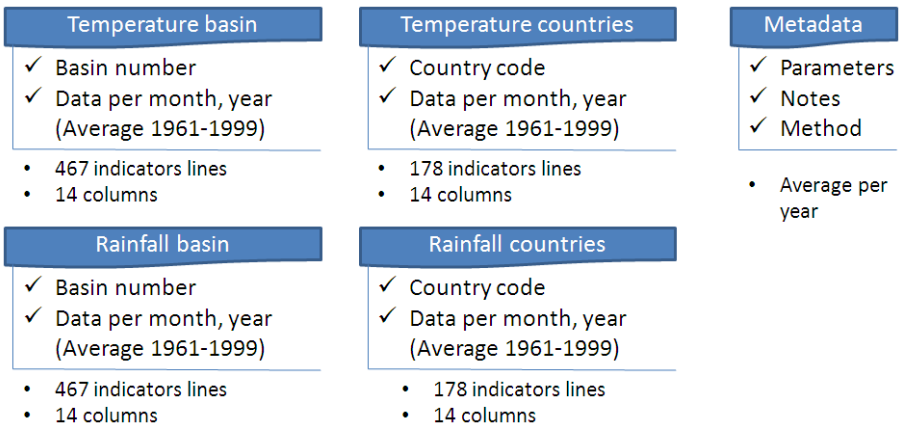

Fig. 5. Existing metadata

After studying the existing data, we found that there are a lot of data and documents related to climate change to be processed. Thus, it becomes necessary to have a system for collecting, analyzing and interpreting these data catalogues available to us. In the section dealing with results, we will propose a modelling of existing information and data to achieve a physical data model easily used and complying with certain standards and rules.

4. Results

To reach our final goal, we have proposed a conceptual model that is in conformity with all our requirements, namely: a widespread accessibility no matter the level and the disadvantage of the user. If we talk about level, we mean that the MapClim system must enable any given user, to view via the web, the proposed indicators and easily understand their signification in a context of reduction and adaptation to climate change. The user, after consultation of various proposals on the web, must be able to contribute to the reinforcement of capacities building for that issue according to the user expertise and the indicator. In our analysis, we have proposed a model based on information in the form of texts, sounds, images and videos. This allows all users to easily understand the results of the analysis. The solution is composed of four main parts: the first part allows some authorized users to do some data entry for the MapClim system to be updated with data coming from the most decentralized places like the village. The second part deals with the analysis that uses annual data collected since 1960 and recent data after a validation phase by experts from the concerned country at a national level. The analysis enables to issue alerts quickly in case of a prediction of a problem (hazard). The third part is for registered experts to interpret and put this information into the system so as to allow users to see the results via one of MapClim modules. The fourth and final part consists of utilities to make easier the use of the system, for example, a module that allows to import and export data in a given format (Word, Excel, PDF, CVS, XML ...). It enables to update quickly MapClim with global data on climate change. A module for mobile phones is also available.

4.1. Modelling

The physical model shown in Fig. 6. is composed of different tables and areas to enable the dynamic management of indicators and places. Those places are highly structured to the villages or towns. In our model, an indicator may be associated with a country or a region (country unit). An indicator may have different languages or dialects with images, sounds and video standards. For the systematic collection of data, the indicator is associated with a city or a village in the most detailed way. The data are grouped together at the district and then at the national level (or according to the administrative model of decentralization) before being included into global databases. Experts in the field of climate change can analyze the data and make interpretations through interpretation table that is associated with indicator tables and country .

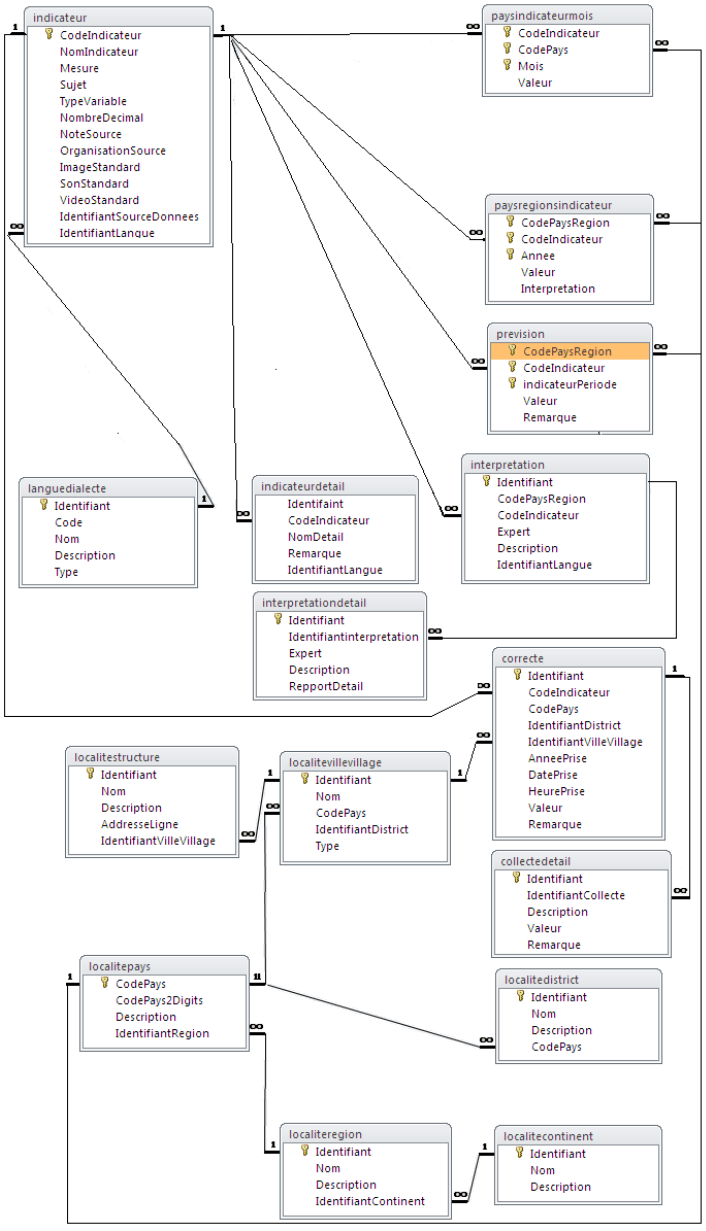

Fig. 6. Physical data model of MapClim

4.2. MapClim System

MapClim is a functional computer system on the web which is composed of five main applications: collection with MapClim Collection, analysis with MapClim Analytics, interpretation with MapClim Interpreter, tools with MapClim utility and mobility part is compatible with Mobile MapClim with iPhones and solutions based on mobile operating android system of Google. In this article our description will focus on the three first applications of MapClim (Collection, Analytics and Interpreter).

4.2.1. MapClim Collection

Systematic data collection is important for updating databases at local, national, regional and global levels. Our approach is based on the collection at the lowest and closest level of the population. We mean by this that data will be collected at the community level and will be ascended to the national level. The latter can group together all the data from these various intermediate levels, make the synthesis before sending them to the global level to make it available to everyone. MapClim collection is a web component that enables to make data collection community based on indicators of climate change. In Fig. 7., the authorized user can enter data collected locally. The interface takes into account the places from the village or town to the national level. It enables to select the frequency, the year, the day and the time of collection. One can also put comments through a word processing tool integrated into the form. MapClim Collection also enable to make detailed collections compared to the proposed indicators. For example as shown in Fig. 7., we can collect data on the indicator "Total population" by using four more detailed descriptions "Total population children girls," "Total population children boys", " Total population adult women" and "Total population adult men. "This subdivision provides more flexibility and possibilities to our system.

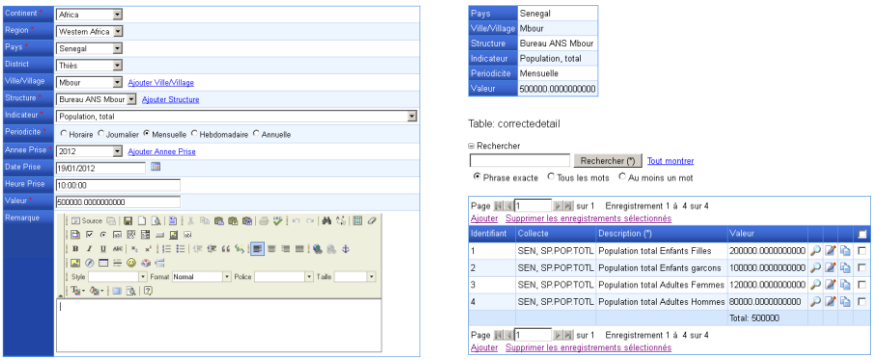

Fig. 7. Data collection interfaces of MapClim

4.2.2. MapClim Analytics

From archived data since 1960 and newly collected data, MapClim enables to do analysis by using graphs for a better understanding. Several types of graphs and maps can be created by defining the criteria of representations. All indicators treated for the 15 countries of the West African region can be analyzed and interpreted. MapClim allows Scientists, experts of developments, decision makers and other users to exploit data on climate change so as to take swift and efficient actions for adapting to climate change. The following figures show some examples of graphs and maps as decision making tools. These graphics are made directly with data retrieved from the MapClim database on indicators by country and by region. Comparisons are also possible either within a country, between districts, towns or villages or between countries of West Africa.

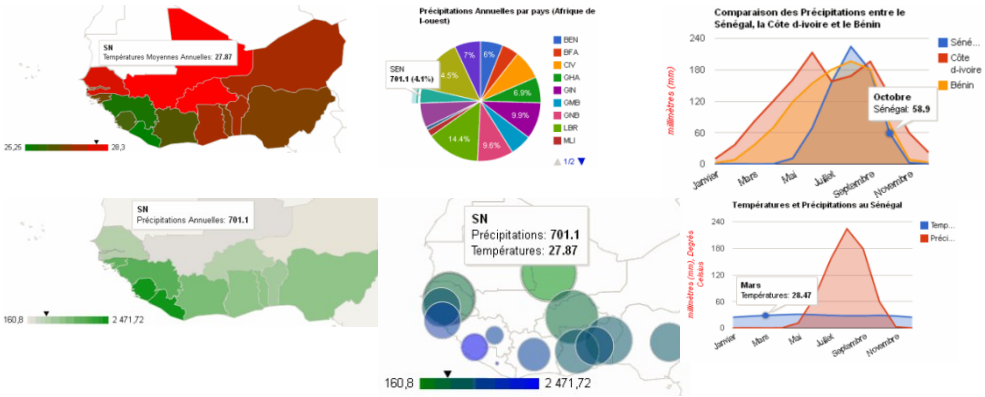

Fig. 8. Graphs and maps for MapClim analysis

4.2.3. MapClim Interpreter

The interpretation of new and old data is an important part of our system because this action gives more value to MapClim. Experts can analyze data and suggest reports that policy makers can use to issue warnings in need or to adapt measures. The interpreter's role is to provide reliable information using newly collected data with the support of archived data since 1960. MapClim allows him, with a user interface, to make his report available to the system (see Fig. 9.). The report is always intended to the authorities first (with the assistance of the national platform for disaster risk reduction or other specialized structure), which in turn can validate and authorize its extension into the system so that other users can view it. MapClim also allows authorities to keep it only for them for national security reasons . Some sudden actions can rather destabilize than inform people. Only authorities can publish some information. An interpretation may be detailed and allow other experts to give their opinion.

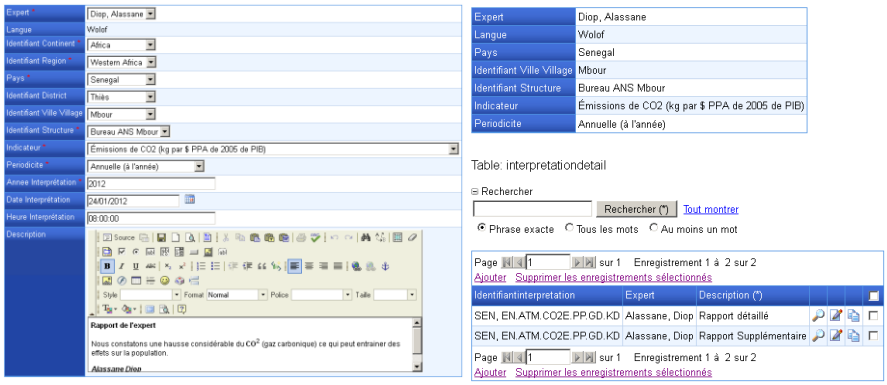

Fig. 9. Interfaces for interpreting MapClim data

5. Discussions

MapClim system offers an online and mobile platform that allows to achieve a permanent state of wakefulness and to take swift and efficient actions for adapting to climate change. Several modules can be used and can be adapted according to the user's level. The fact of focusing our analysis on the accessibility and exploitation of the archive for several years, the introduction of new data with the proposal of collection and systematic interpretation of data and forecasting to 2100. The use of MapClim can enable the most relocated people to have continuous and reliable information on climate change and to be able to make contributions with real and preventive actions. In the case of our study, the 15 countries of West Africa are experiencing problems with the use and the consumption of energies like electricity. The latter represents an important indicator for climate change. The use of renewable energies such as solar can enable those countries to take actions to adapt energy and its use by people in most remote areas. The expansion of Internet across the 15 target countries of our study will enable MapClim data to be more accessible. Solutions are being developed by our research team and other researchers to make available solar computers and even solar optimized computer networks.

6. Conclusion

African countries must take adequate measures for the reduction and adaptation to climate change. Africa in general and more particularly West Africa, considerably lacks computer solutions and structured information systems. The objective of MapClim is to contribute to the reduction and adaptation to climate change with the introduction of computer tools free of use. We must note that the establishment of an early warning mechanism to climate change can help save lives with a rapid activation of the device of the organization plan of the response of civil security, by minimizing the risks of natural disasters or by taking real and swift actions to move people to safe areas (mitigation). MapClim will therefore mobilize communities and

authorities in West Africa for a wakefulness state (information process by which one seeks information to anticipate developments of risks and vulnerabilities) so as to reach a real adaptation to climate change.

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