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Research Article

Evaluating a Fit-for-Purpose Integrated Service Platform for Climate Change and Land Information of Rural Mountain Community

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ABSTRACT

Climate change challenges rural mountain communities to adapt and reduce this vulnerability. They need a developed web-based information system that enables communities and people for preparing plans to reduce their impacts. The system provides a user interface that visualizes data collected from different data providers, integrating it with near real-time climate and weather datasets. It was tested for rural mountain communities particularly those in the Dolakha district of Nepal. The result illustrates system can provide information such as present land use status, near real-time rainfall and temperature details, and present adapted techniques that enable communities and its Stakeholders to formulate a plan for coping the climate change. Overall, the system aims to support simple and easy access, visualizations and querying of the information for the relevant stakeholders, individuals, and communities. This information can facilitate policymaker for improving and implementing community-based activities in rural mountain community.

Keywords: Climate change adaptation techniques; Integrated service platform; Rural mountain community; Fit for purpose; Climate change; Land information system

INTRODUCTION

Rural mountain community is on urge of technologies with information and adaptation measures to reduce the impacts of climate change. According to different research findings this community are a thing her risk of social and environmental impacts. Moreover, amount a in community pose minimal resources to adapt socially, technologically and financially. As they have settled in high altitude, dense fog, heavy rain and snow, even falling rocks and landslide. People are out of reach with infrastructure such as electricity, internet, and mobile network. This is as communities are scattered in small populations, and remote locations. In rural societies, the poorest people of ten have weak run protected tenure rights [1]. To address this community situation: Information Communication Technology (ICT) can play a substantial role in strengthening community adaptive capacity [2]. For establishing new ICT infrastructure in this areas is more challenging and time-consuming to transfer the required supportive infrastructure, for example, roads and transport, are often unavailable or improper condition. Instead use of proper ICT tools such as mobile and web-based information interfaces can present a wide variety of information about the current status of land and climate change, For instance, Shack/Slum Dwellers International (SDI) provides information on community risk reduction in 33 countries in Africa, Asia, and Latin America [3]. Only Fog Watch application can be considered a climate change relevant mountain IS application: it provides information about fog density in 'Indo-Gangetic Plain and Brahmaputra Basin' [4].

In this study, an interactive web based system of integrated land and climate change information is developed with purpose to promote community based activity. This system is intended to provide an information about land and climate change, such as land use, administrative boundary, contour, hydro line, Cadastre, road network, near real-time temperature and precipitation, which support individuals, and communities to access, visualize, and query information in a simple, easy and better approaches.

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MATERIALS AND METHODS

In this section the criteria for case selection and data collection processes are discussed. After that system development process is then explained, as are the system architecture and subsequently the test plan.

Study area and its context

Nepal, one of the most climate affected countries [5] Dolakha district is selected since it is ranked very low on combined/ multiple adaptation capability indices, which include socio-economic, technologic (irrigation system), and infrastructural (road and communication)adaptation capability [6]. The community had many challenges regarding land and climate change (Figure 1). This study proposed the establishment of an web based land information system for supporting and implementation of CBA-based on relevant and high spatial data and services [7].

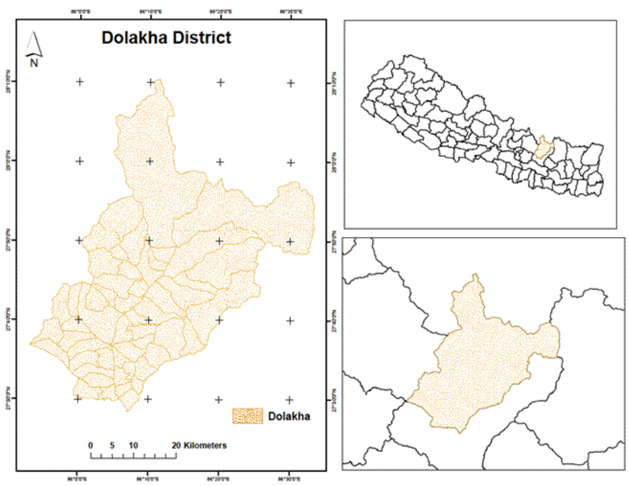

Figure 1: Case study location.

Information system architecture

The system architecture (Figure 2) is designed on the basis of the requirements identified earlier. The architecture is designed with the concept of the web as well as a mobile application for climate change and land information and four tier concept.

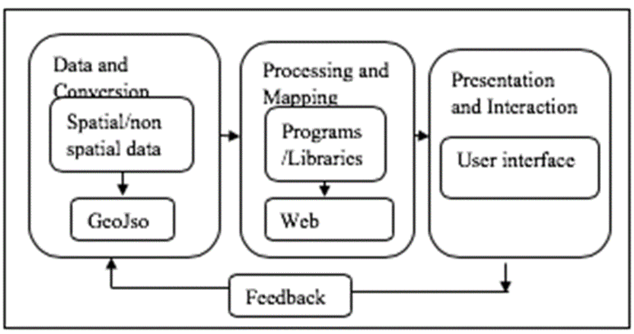

Figure 2: System architecture.

In this above diagram, user can operate the system either by the computer or mobile through any browsers (such as Mozilla firefox, google chrome). With that operation they will be able to visualize webpages with description, map, and responsive form. For creating dynamic and responsive web pages Javascript, Bootstrap, JQuery are used. Similarly, these technologies are the standard web technologies to build web pages that are concise supports cross browser, and mobile platform. *Bootstrap*, is a powerful front-end framework for faster and easier web development. It contains HTML, CSS, and JavaScript framework for developing responsive, mobile projects on the web. Because of this, web pages are created using these technologies [8].

A secondary source of vector data isused for building the land and climate information system. These formats of data can be represented in its original resolution and form without generalization. Therefore, these formats of data recollected by the organizations such as the International Center for Integrated Mountain Development (ICIMOD), Land office and District Forest Offices (DFO) [9]. Similarly ,the secondary source of data (i.e. Comma separated format) is gathered by the Meteorological and Hydrology office for the climate change with temperature and precipitation [10]. Even the online source is used for real-time weather data that is open weather map. This provides near real time, temperature and precipitation, which will be useful for the users. These sets of data are used in the system with the aim to provide for land and climate change information to the stakeholder of the mountain community [11].

The created GeoJson are published as vector layers such as point, line, and polygon using leaflet. A leaflet is an open source Javascript library for mobile friendly interactive maps. It is light weight, support cross browser, includes mapping features [12]. Therefore leaflet is used to visualize spatial and non-spatial data on the web map. Above all used software technologies are free and open source. With the use of such technology increase the system interoperability, credibility, reliability, sharing and lower cost [13].The users can use this application to web browsers on a mobile or laptop device with Mozilla Firefox, Internet explorer, Google chrome. Nowadays web based browsers are pre-installed on the mobile devices. This will increase users furthermore, there is no need of installing the client in the mobile device, thus reducing the deployment time and cost [8].

User test plan

A workshop at Kathmandu University (KU), Dhulikhel, Nepal on 5 September 2016, was heldto evaluate the system prototype. KU supported the test with the Internet connection, space, and computers. Total 12 participants were involved in this process, Figure 2 presents a summary of the responses to the questionnaire. Although the aim of the survey was primarily to test and evaluate the system usability, functionality, simple, user-friendly, easy to operate from the questionnaire and open-ended tasks. From this data collected which results are represented in a bargraph. The questionnaire was provided to a broad group of potential respondents. The survey started with a set of definitions to ensure uniformity in understanding the terminology used [9].

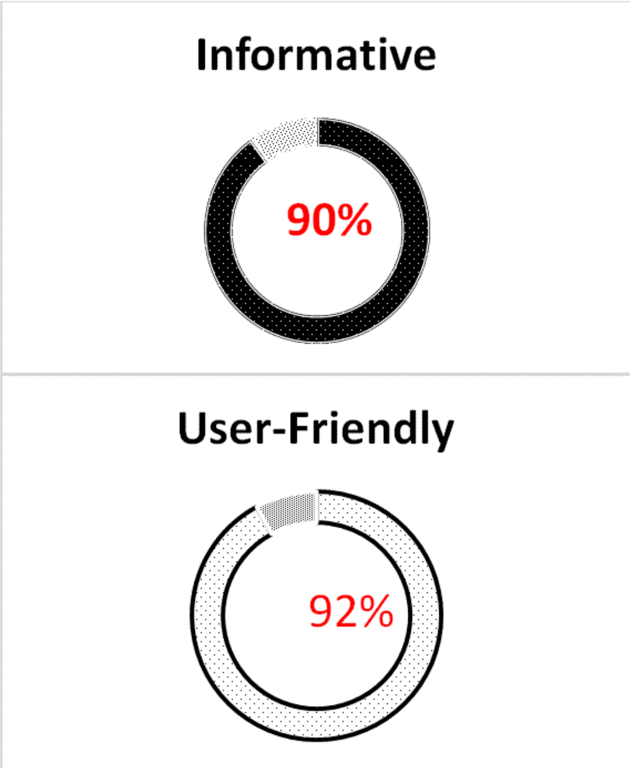

Figure 3: Charts shows the result of a questionnaire, responded by the users.

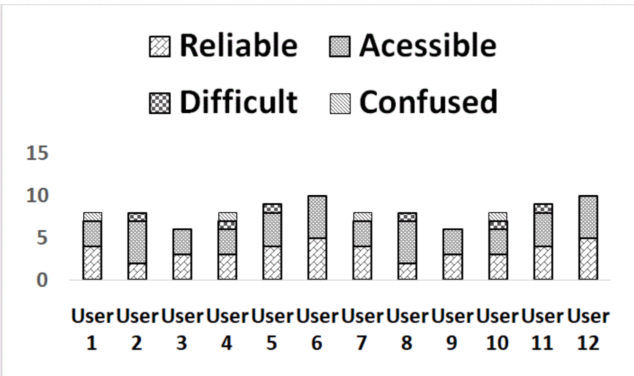

Figure 4: The graph illustrates the result of a user test.

This charts illustrates that 12 participants responded in a such way that more than 90 percent conclude that system is informative and user friendly (Figure 3). Also user mentioned its more reliable and accessible (Figure 4). As compare to difficult and confused while operating this system. This result have shown enormous scope of such web based technologies for rural community to provide land and climate change information [14].

Figure 5: Differently called the system by the users.

During the user test, people perceive and named the system in their natural way. This has been illustrated in the above world cloud visualization (Figure 5). Such activity indicate they find it useful and get associated with such new technology and system [15-17].

RESULTS AND DISCUSSION

The users are able to switch a specific layer and extracted information from its sub-layers. By layers on or off the sub-layers, land and climate data were presented on the base map. The participants could make queries by clicking on the map. A pop-up window showed information about the clicked point on the base map (Figure 6). When the participants selected a meteorological station, a ten year (2000-2010) rainfall and temperature graph appeared in System. The system was interactive and easy to switch layers perceived by every participants.

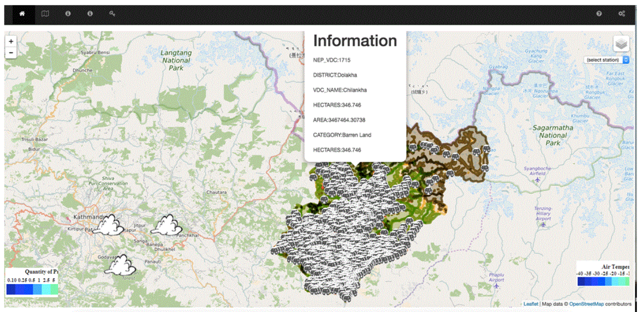

Figure 6: Above represents selected layer and result of a query on the system.

A user could select the desired base map from right Panel, villages and municipalities and their administrative boundaries, land use category (land use, cultivation, forest, and barren areas), road network, hydro lines, contour ortophotographic map, land parcels, information about three Village Development Committees (VDCs), adaptation options and rainfall and temperature data from dropdown menu located on right below base map layer. The user could zoom in/out on the map via the ± buttons located at the top left-hand side (this function also applies to other figures that were presented in this study).Rainfall and temperature graph. A user could select the desired meteorology station from the top right-side panel that included the three meteorology stations of Godavari, Kathmandu, andNagarkot.

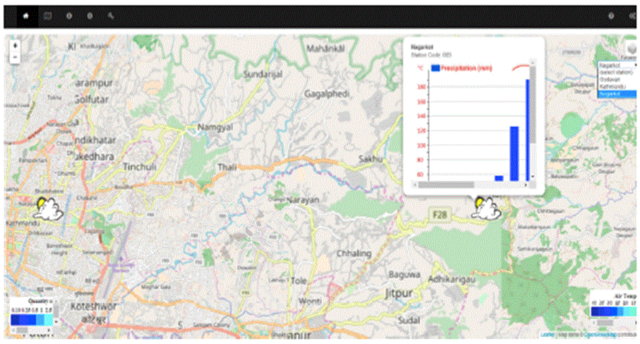

Figure 7: Above figure shows the rainfall information.

In this figure, a user selected the Nagarkot station. A pop-up window displayed information in a bar graph about the temperature and rainfall of 10 years (Figure 7). TheTemperature information were shown in one graph and rainfall in a symbolic represent with cloud, rain, and sunny day. The Y-axis illustrated annual temperature in °C, and the X-axis visualized yearly rainfall in mm for the selected location. It displayed climate information related to that particular meteorology station (Figure 8).

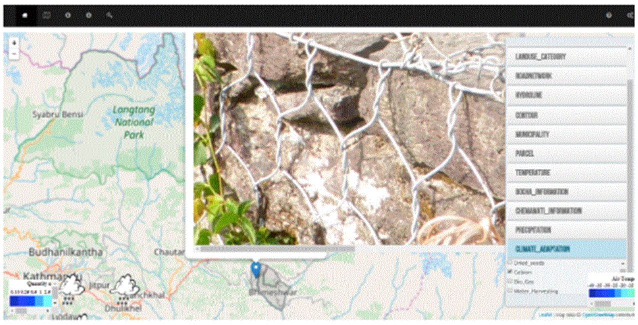

Figure 8: Represents the climate-adaptation layer.

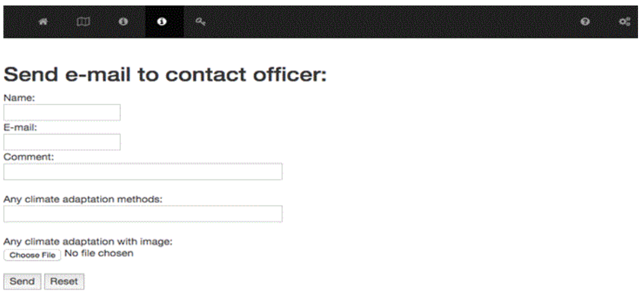

Figure 9: Represents the feedback form.

Four of the participants fill in the feedback form (Figure 9) that was designed for the communities/individuals to share their experience about the impacts of climate change, time and the location of climate change events and their needs. The climate-adaptation layer created the opportunity for mountain communities/individuals to share a CBA option with an image as a"bottom-up" approach to support "crowdsourcing". The system had already populated the climate-adaptation layer with some photos of adaptation options for the purposes of testing. The climate-adaptation layer supports community/individual to be visible. The shared photos of climate-adaptation experiences provide information about the available resources and useful for other communities/individuals.

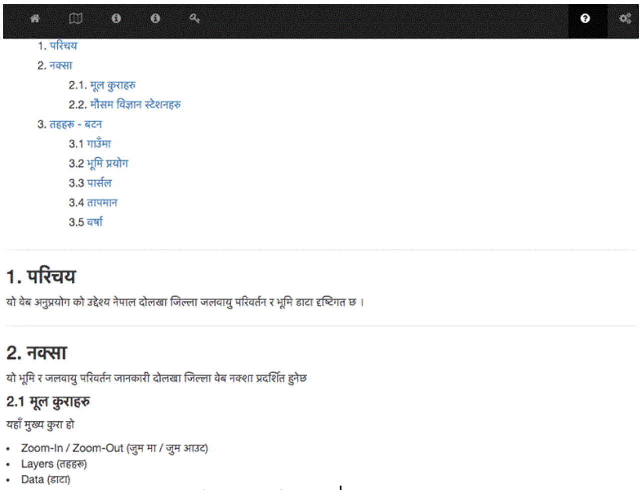

Figure 10: Represents the switch on languages.

This top right hand (Figure 10) corner provide user to switch three languages English, Nepali, and German. It make system usable and understandable both groups such as literate and illiterate in a community. Based on the results, it is concluded that the system exhibits an ability tosupporta user could select the desired base-map, layers: villages and municipalities and their administrative boundaries, land-use category (land use, cultivation, forest, and barren areas), road network, hydrolines, contour ortopographic map, land parcels, information about three Village Development Committees (VDCs), adaptation options and rainfall and temperature data. Evaluating a Fit-For-Purpose Integrated Service-Oriented Land and Climate Change Information System for Rural Mountain Community. Overall this system is technically easy to interact and function however there still some issues should be considered for successfully implementing in the desired societies. The issues would be crowdsourcing interaction and important would be people will show eager to learn and implement it, for their daily life. In summary, some of the elements have not been fully satisfied in this study, but they have the potential to be achieved with further research and development.

CONCLUSION

This paper describes how you can use ICT tools to provide and promote climate change and land information for the rural mountain community. The result of the user test revealed the importance of system in supporting climate adaptation services. Also, it illustrates free and open sources can be used to integrate spatial and non-spatial data for providing reliable information to the community. This study has been initial step how you can create and share information using mobile as well as a web platform. Furthermore, this could be developed and improved, which will definitely be milestone for both ICT as well as CBA.

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