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GEOINFORMATICS FOR MAPPING CLIMATE CHANGE VULNERABILITY

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ABSTRACT:
Vulnerability assessments are important tools for revealing the most harmful environmental and societal impacts of climate change. Development agencies use them to identify climate change regions at the hotspot and formulate appropriate adaptation measures accordingly. In this context, our work demonstrates how to use a standardized approach to vulnerability assessments and emphasizes the need for Geoinformatics as key tools to include spatial analysis and vulnerability mapping in output evaluation and visualization. Preliminary findings from a vulnerability assessment conducted for J&K indicate the possibilities of using such a strategy, however, there are limitations as well that lie primarily in impact assessment, selection of indicators and reliability and heterogeneity of datasets.

Keywords: Geoinformatics, Mapping, Vulnerability, Himalayas, Indicators

INTRODUCTION

Variation to weather exchange influence has become one among the primary issues of the global development cooperation. With a purpose to discover the populations, regions or sectors most prone to weather, alternate consequences, global and national decision-makers, planners and development groups are increasingly relying on the results of vulnerability tests (Schipper et al., 2009). However, given the multitude of definitions of vulnerability and related terms, in addition to the form of methodologies, clean conceptual method for operationalizing and visualizing vulnerability is lacking (Gallopin, 2006). Keeping this in view, we advocate a consistent indicator- based approach to assess vulnerability in the Himalayan regions. Geoinformatics can play an important role, that can be utilized from the very starting of the evaluation, along with data management, spatial analysis, mapping and tracking of consequences (Kienberger et al., 2009). It permits the detection of differences in vulnerability in space, and depending on data availability, it looks at the phenomenon at one different spatial scale. Some of the models utilize spatial multi-criteria decision analysis, combined with a geographic information system (GIS) platform can be generalized to assess the vulnerability (Nghiem et al., 2015). Making decisions and efficiently allocating resources to reduce the vulnerability requires, among other things, an understanding of the factors that make a society vulnerable to climate and coastal hazards. One way of doing this is through the analysis of spatial data. Mapping illustrates that vulnerability is not evenly distributed across regions and is not driven by the same factors in all areas (Weis et al., 2016). The IPCC (2014) concluded that reducing vulnerability to the risks from current climate variability is the first practical step to curtail losses and would be a reliable and 'no-regret' approach to reduce current vulnerability and build long-term resilience under climate change. Köhle et al., (2016) analysed the Intergovernmental Panel on Climate Change (IPCC), 2014 framework which suggests that an important increase in frequency and magnitude of hazardous processes related to climate change is to be expected at the global scale and provided a new framework for risk assessment and mapping which enables countries with limited data sources to assess their risk to climate change related hazards at the local level, in order to reduce potential costs, to develop risk reduction strategies, to harmonize their preparedness efforts with neighbouring countries and to deal with trans-boundary risk.

In this study we examine the various methods in context of IPCC methodology framework and tried its applicability for implementing the adaptation project. The aim of the assessment was to discover the areas which are most vulnerable to climate change. The focus was maintained on the agricultural sector as marginal farmers are most vulnerable communities to climate change

METHODOLOGY

The method is based on a realistic interpretation and implementation of the IPCC AR4 concept. Vulnerability has been conceptualized as an internal property of a system that is a function of its current endogenous lack of (adaptive) capacity to overcome the adverse impact (its sensitivity) of a stressor. In anticipation of a climatic hazard or a non-climatic stressor, therefore, vulnerability of a natural ecosystem or socio-economic system is assessed as a function of its exposure (the extent to wish as system is exposed) its sensitivity (that determines the first order impact of a hazard/stressor on the system) to such hazard/stressor and its lack of (adaptive) capacity to overcome such sensitivity (IPCC 2007):

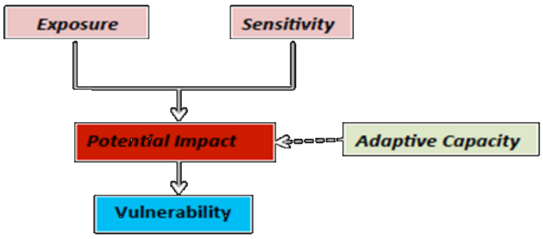

Fig. 1: The components constituting vulnerability according to the IPCC concept

The three vulnerability components are composed of so-referred to as factors, which again are composed of various signs describing every issue. Indicators on this time period have to be to be had spatially referenced, so that they are able to be utilized in GIS for aggregating the components to the potential effect and vulnerability. Following this technique, we recognized seven key steps of vulnerability assessment and mapping:

Step – 1: Selection of spatial scale and period for vulnerability assessment:

Vulnerability assessment could be carried out at different spatial scales, i.e., micro scale (village or household level) or macro scale (district or state level). It could also be carried out for different time periods, i.e. current, short-term (2030s), mid-term (2050s), and long-term (2100). The present assessment is carried out at the macro scale i.e., district level, and for the current climate period.

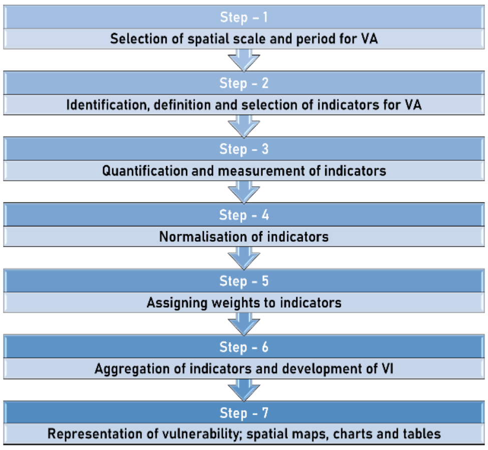

Fig. 2: The seven steps of vulnerability assessment and mapping

Step – 2: Identification, definition and selection of indicators for vulnerability assessment: This is one of the most crucial steps in vulnerability assessment as the outcome is highly dependent on the choice of indicators. While choosing the indicators, several factors have been considered viz. type of indicator (i.e. whether it captures 'sensitivity' or 'adaptive capacity'), and nature of indicator ('Bio-physical' or 'Socioeconomic'). Indicators have been selected through expert consultations.

Step – 3: Quantification and measurement of indicators: Data, in quantifiable units are required for estimating the vulnerability index. As such, reliable sources of secondary data are used to quantify the indicators selected. For example, the indicator percentage of area with slope > 30% is quantified by using the Digital Elevation Model (DEM) data.

Step – 4: Normalisation of indicators: Different indicators are measured in different units (e.g. area under forest in terms of sq. km, Population density person/unit area, per capita income in Rupees, etc.). In order to aggregate the indicators, they have to be normalised or made unit-free.

Step – 5: Assigning weights to indicators: Weights are assigned to each indicator according to their importance in determining vulnerability of a system. To get reliable results, appropriate weight to each indicator has to be assigned. Weights are assigned thorough discussion and consultation with the stakeholders While assigning the weight, it was ensured that the weight assigned to all the indicators, add up to 100.

Step – 6: Aggregation of indicators and development of vulnerability index: Aggregation of different indicators with weights is necessary to obtain a composite aggregated vulnerability index or value. For this, the weights are multiplied with the normalised indicator value and then aggregated to obtain the overall vulnerability index and ranking value.

Step – 7: Representation of vulnerability; spatial maps, charts and tables of vulnerability profiles and index

The obtained vulnerability index value can be represented with the help of tables, charts and maps.

PRELIMINARY FINGDINGS

We used a variety of data sets from national and global sources (regional climate models, LULC layers, population density, digital elevation models, slope aspect, etc.) as given in Fig-3

The values/attribute data was filled in for vector layers and then these layers were converted raster layers. Then the layers for exposure, sensitivity and adaptive capacity were developed using raster calculator. These three layers were aggregated again using mathematical algorithms to derive the final vulnerability maps (index based and ranking based).

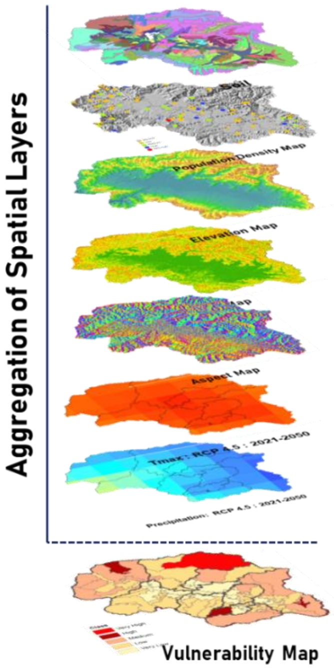

Fig . 3: Mapping of Datasets

CONCLUSION & RECOMMENDATION

Our indicator-primarily based approach of assessing and mapping vulnerability is strongly depending on the utility in a GIS, which goes beyond normal mapping of vulnerability. Evaluating spatial information competently within a vulnerability framework requires integration of machine learning and local knowledge aided with expert advice for the evaluation and weighting of the various indicators. This knowledge can be generated through national/international level workshops besides holding consultations with the local stakeholders. Probably, GIS can function as participatory instrument for discussing exceptional vulnerability elements or suitable indicators, or as a platform of visualisation and tracking of vulnerability consequences (geoportals). On the grounds, that vulnerability tests are enormously complicated and cover a vast field of clinical studies, an extensive variety of statistics on extraordinary spatial and temporal scales, is recommended. In this context, the restrictions of our approach lie specially inside the robust dependency of reliable datasets and suitable signs. Additionally, the heterogeneity of spatial scales and resolutions of datasets isn't sincerely solved.

Although, this standardised approach of vulnerability assessments and mapping cannot simply illustrate climate change vulnerability, but furthermore provide scientific input to the improvement of edition measures through development agencies on a local and national level. Additionally, the vulnerability assessments can be suitable in assisting the monitoring and evaluation of adaptation practices in future.

REFERENCES

Dubois, N., Caldas, A., Boshoven, J. & Delach, A. (2011), Integrating Climate Change Vulnerability Assessments into Adaptation Planning: A Case Study Using the Nature Serve Climate Change Vulnerability Index to Inform Conservation Planning for Species in Florida, Washington D.C.

Gallopin, G. C. (2006), Linkages between vulnerability, resilience, and adaptive capacity; Global Environmental Change, 16 (3), 293-303.

IPCC (2007), Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Penal on Climate Change. Ed. by PARRY, M. L. et al. (Eds.), Cambridge University Press,Cambridge, UK, 976 p.

IPCC. 2014. Summary for Policymakers. In: Field, C. Barros, V.R., Dokken, D.J., Mach, K.J., Mastrandrea, M.D., Bilir, T.E., Chatterjee, M., Ebi, K.L., Estrada, Y.O., Genova, R.C., Girma, B., Kissel, E.S., Levy, A.N., MacCracken, S., Mastrandrea, P.R., White, L.L. (Eds.). Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1–32.

Joy, Jean Kanga., Shruti and Singh, Suraj Kumar. 2019. Kerala Flood 2018: Flood Mapping by Participatory GIS approach, Meloor Panchayat" International Journal on Emerging Technologies, 10(1): 197-205

Kienberger, S., Lang, S. & Zeil, P. (2009), Spatial vulnerability units – expert-based spatial modelling of socioeconomic vulnerability in the Salzach catchment, Austria. In: Natural Hazards Earth System Sciences, 9, 767-778.

Köhle,P., Promper, C. and Glade, T. (2016). A Common Methodology for Risk Assessment and Mapping of Climate Change Related Hazards—Implications for Climate Change Adaptation Policies. Climate Risk Assessment and Management, Vol. 4(1).

Nghiem Q. H. (2015). GIS-based Spatial Multi-criteria Analysis: A Vulnerability Assessment Model for the Protected Areas of Vietnam. Journal for Geographic Information Science, Vol. 1, 103-111.

Schipper, E. L. F. & Burton, I. (2009), Understanding adaptation: Origins, concepts, practice and policy. In: SCHIPPER, E & BURTON I. (Eds.), The earthscan reader on adaptation to climate change. London, UK and Sterling, VA, USA, 1-9.

Singh, Suraj Kumar. 2017. Delineation of waterlogged areas in Vaishali district (Bihar) using normalized difference water index. SGVU J Clim Change Water, Vol. 4, 2017 pp. 33-37

Singh, Suraj Kumar. 2017. Evaluation of flood and waterlogging dynamics in indo-gangetic plain using geospatial technique: a review, Open Access International Journal of Science and Engineering, 2(3), 1-7.

Singh, Suraj Kumar., & Kanga, Shruti. 2017. Mapping of salt affected and waterlogged areas using geospatial technique, International Journal of Recent and Innovation Trends in Computing and Communication, Volume: 5, Issue: 5, 1298 – 1305

Sohail, Abu, Talha., Singh, Suraj Kumar and Kanga Shruti 2019. A Geospatial Approach for Groundwater Potential Assessment Using Multi Influence Factor (MIF) Technique. International Journal on Emerging Technologies 10(1): 183-196

Weis, S.W.M., Agostini, V.N., Roth, L.M., Gilmer, B., Schill, S.R., Knowles, J.E. and Blyther, R. (2016). Assessing vulnerability: an integrated approach for mapping adaptive capacity, sensitivity, and exposure. Climate Change Vol.136 (3-4), 615-629.