ECOLOGICAL DATA AND THEIR MODELING METHODS

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Abstract. With the rise of large-scale environmental models comes new challenges for how we best utilize this information in research, management and decision making. Interactive data visualizations can make large and complex datasets easier to access and explore, which can lead to knowledge discovery, hypothesis formation and improved understanding. Here, we present a web-based interactive data visualization framework, the Interactive Catchment Explorer (ICE), for exploring environmental datasets and model outputs. Using a client-based architecture, the ICE framework provides a highly interactive user experience for discovering spatial patterns, evaluating relationships between variables and identifying specific locations using multivariate criteria.

Keywords: interactive data visualization; visual analytics; web application; web GIS; geospatial datasets; environmental modeling.

Introduction. Large-domain modeling is an important advancement in the environmental sciences. Models covering broad spatial areas are expected to improve our ability to study, monitor and manage natural resources at regional, continental and even global scales [1,2,3]. Modeling at this scale is increasingly feasible thanks to the growing computational power of desktop and cloud computing platforms, as well as the availability of large-scale and spatially continuous meteorological and geospatial datasets [3]. Large-domain models facilitate research and management not only at broad scales but also at local scales by providing spatially consistent datasets for filling data gaps (e.g., estimating streamflow in ungaged basins) and supporting site-specific assessments and comparisons. However, along with the benefits of large domain modeling come new challenges for how we best utilize the often large and complex datasets generated by these models.

Materials and methods. In the era of Big Data, discovering meaningful patterns in large datasets is a common challenge in many fields [4,5]. In the environmental sciences, geospatial datasets and model outputs spanning large areas can contain a wealth of information. However, due to their sheer size and complexity, model datasets are often inaccessible to the vast majority of interested stakeholders, resource managers, policy makers and researchers. Consequently, it is common that only those who developed the models or that have the experience and technical skills necessary to analyze the results are able to use them to derive new insights and knowledge. However, other stakeholders and researchers, whose backgrounds, goals and interests likely differ from the original model developers, could benefit from using these datasets to form their own hypotheses, discover new patterns and develop a better understanding of the processes and systems in their own area of interest.

Results and discussion. Interactive data visualizations can be effective tools to help us better understand datasets and the phenomena they represent through a process known as visual analytics [4]. Card et al. [5] defined data visualization as “the use of computer-supported, interactive, visual representations of data to amplify cognition”. Liu and Stasko [5] argue that interactive data visualizations are useful because they facilitate the formation of mental models, which can play an important role in management and decision making [2]. Interactive data visualizations can also be useful for helping us iteratively form and test hypotheses [3]. As a result, instead of being the end-product of the research process and intended solely to communicate study results, data visualization has become an integral part of an iterative scientific workflow helping researchers form hypotheses and better understand their own datasets and analyses [2]. In short, interactive data visualizations are tools that help us not only to see the data but also to think about the systems and processes they represent.

Advances in web technologies and standards have led to a proliferation of free and open source software (FOSS) libraries for creating interactive data visualizations on the World Wide Web (the Web) [4]. The Web has long been recognized for its potential to improve environmental management by making data and models more accessible and for fostering cooperation and collaborative decision making between stakeholders [2]. This improved accessibility can also facilitate inter-disciplinary research by making datasets available to researchers from other fields who may not have the experience or skills necessary to access and analyze the data themselves [3]. These tools can help others discover new patterns that may not have been previously known even to the original creators of the dataset [3]. Furthermore, by linking to underlying data sources, Web-based interactive data visualizations can integrate new information and data as they become available.

The Crown of the Continent Ecosystem (CCE) is a biologically diverse region in the northern Rocky Mountains ranging from central Montana in the United States to southern British Columbia and Alberta in Canada (Figure 1). The CCE is home to two native salmonids—bull trout (Salvelinus confluentus) and westslope cutthroat trout (Oncorhynchus clarkii lewisi)—that are under threat from multiple physical, biological and climatic stressors [4]. Researchers at the USGS Northern Rocky Mountain Science Center conducted a climate change vulnerability assessment (CCVA) of these two species to understand the relative risk of populations to climate change, invasive species and habitat loss. The goal was to provide this empirical information to natural resource managers and stakeholders to inform proactive conservation and restoration actions for improving native trout resilience and adaptation across the transboundary ecosystem.

Building on an approach described by Wade et al. [4], the CCVA incorporates the climate sensitivity, exposure and adaptive capacity of each species to quantify a series of relative risk scores based on empirical studies across space and time. The input datasets for this assessment included geospatial characteristics (e.g., land use, hydrography), presence/absence data, demographic and hybridization metrics, habitat availability, climate conditions and modeled stream temperatures. Based on these input datasets, risk scores were calculated and assigned to conservation populations of westslope cutthroat trout (n = 497) and bull trout (n = 123) in the CCE. The risk scores were generated for four future climate change scenarios based on two emissions trajectories (Representative Concentration Pathways (RCPs), 4.5 and 8.5) and two time horizons (years 2035 and 2075). The area associated with each conservation population was delineated based on spawning and rearing habitat containing the known presence of genetically similar individuals (i.e., local populations). The results of this vulnerability assessment along with the input datasets provided a basis for understanding where native salmonid species are most at risk and which factors are the primary contributors to vulnerability.

For this ongoing project, researchers are generating a series of datasets related to streamflow conditions and the degrees of flow alteration using a variety of statistical analyses and hydrologic models. These datasets are being generated for both the USGS streamflow gages (n = 956) as well as all 12-digit hydrologic unit code (HUC12) basins (n = 9314) in the region. Input datasets include the drainage basin characteristics (e.g., land use, topography, hydrography), hydrologic indices (e.g., base-flow index, topographic wetness index) and climate variables (precipitation, air temperature) for both the gages and the HUC12 basins as well as observed streamflow statistics for each gage. Output datasets include estimated streamflow quantiles (i.e., flow duration curves) of all HUC12 basins based on a neural network model [5] and the results of a long-term trend analysis based on observed flows at each gage. For both the input and output datasets, most variables contained time-varying values that were computed for each decade from the 1950s through the 2000s. As this project continues, additional datasets will provide a series of metrics representing the degree of streamflow alteration over time for each gage and HUC12 basin. Together, these datasets are meant to help local, state and federal agencies and decision makers to understand the spatial and temporal patterns of streamflow alteration and help them to prioritize basins for future flow restoration.

Conclusion. The ICE framework demonstrates a Web-based interactive data visualization approach to explore the spatial patterns in environmental datasets and model outputs. We applied this framework to datasets and models from three separate research projects, each focusing on a unique research topic and management issue in a specific region of North America. Based on our experience developing these applications, we found that not only can web-based data visualization tools be used for accessing, exploring and understanding large geospatial datasets, but these tools can also provide a number of broader impacts that go beyond any one user.

REFERENCES

1. Odiljon Abdusattarov. Environmental monitoring geospatial data visualization methods. Prospects of development of science and education , 2023 1(10)

2. Toshpulatov, D., Nosirov, B., & Khalmatov, T. (2021). Gradual Implementation of Smart Management Principles in The Higher Education System of Uzbekistan. *International Journal on Economics, Finance and Sustainable Development*, *3*(1). 22-29.

3. Б.А Кулматова, Д.А Буранова, З.А Запаров.- Способы защиты от интернет-мошенничества, Научно-методический журнал Academy 2019 г 78-80 ст.

4. O.Abduraxmonov “Ko‘p yadroli protsessorda kubik bazisli splaynlar asosida parallel algoritmlarni amalga oshirish tuzilmasini ishlab chiqish” Academic Research In Edicational Sciences Scientific Journal // Vol.2,Issue3.,Pages: 628-633,2021 y.