WEB MAP OF VIETNAM PROTECTED AREAS

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ABSTRACT

Protected areas (PAs) are areas of particular importance for biodiversity and ecosystem services. Increasing awareness, sharing information and knowledge of PAs are key elements for their sustainability. Among sharing information media, web map has become a novel source that provides spatial information effectively and web maps of PAs have been paid attention. In Vietnam, using web maps for sharing information of PAs is less common. In the meantime, one of the cartography advancement results is multiscale map. Therefore, this study aims to develop a multiscale web map of Vietnam PAs. Its objectives are to create maps of PAs at different spatial extensions and publish them as a multi-level web map. This is an empirical research, beginning with literature review on multiscale and web map, to determining spatial extents intended to be viewed and rules for setting the scale range through those extents. Next step is to define symbol transformation across scale range to ensure visual continuity at all scales so that the map communicates effectively. Data was conducted with national parks (NPs) - the type of PAs with highest biodiversity importance. The web map was developed via Esri's ArcGIS Platform. Specifically, GIS data were manipulated, symbolized for desired scales, created as web applications and as web map with ArcGIS Desktop, ArcGIS Pro, ArcGIS online and ArcGIS Experience Builder, respectively.

Research result is a web map of Vietnam PAs with the spatial extents spanning from national, regional, provincial to PA level. Spatial extents for experiment map at regional, provincial and PA level is North Centre Region, Quang Binh province and Phong Nha – Ke Bang NP, respectively. The web map configures basis interactive tools such as legend display, base-map gallery, layer management, measurement, radius search, and selection. Through web map services, spatial information of Vietnam PAs is accessible anytime and anywhere. The result shows that the rules for setting scale range for multiscale map of PA are reasonable and feasible. However, more experiments need to be done so that the rules can be applicable to elsewhere.

1. INTRODUCTION

Protected areas (PAs) are areas of particular importance for biodiversity and ecosystem services. PAs themselves become the Programme of Work in the Convention on Biological Diversity (CBD). They also form a central element of the other programmes of CDB Work. In the Programme of CBD Work on PAs and the World Parks Congresses of International Union for Conservation of Nature and Natural Resources (IUCN), increasing awareness, sharing information and knowledge of PAs are key elements for their sustainability. Among sharing information media, web map has become a novel source that provides spatial information effectively and web maps of protected areas have been paid attention.

With web map, one can access map from any device, anywhere and anytime. GIS

technology advancements during last decades have led to multi-scale web map. Furthermore, web map is currently not only the representation of map but also an interactive tool for spatial analysis (Neumann, 2016). In fact, such web maps of PAs have been developed, such as World Database on PAs, Protectedlands.net, Marine PAs Atlas, Atlas of Pálava protected landscape area, the Bay of Bangle Large Marine Ecosystem Atlas, Sequoia & Kings Canyon Parks Atlas, atlas of the Swiss NP, etc.

Being one of the Earth's most biodiverse countries, Vietnam have push efforts in elaboration of PAs management system. From which, the need for information sharing and awareness among stakeholders are vital (Chu, M. T., 2011). However, web maps for sharing information of PAs is less common. Therefore, this study aims to develop a multi-scale web map of Vietnam PAs. The objectives of the study are to create maps of PAs at different spatial scales and publish them as a web map.

2. THEORIES AND METHODS

2.1 Definition of PAs

The world first PA - Yellowstone national park (NP), was established in 1872. However, it was not until 1994 that the definition of PA was first given by IUCN. The term was then revised in 2004. According to that, a PA is a "geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long term conservation of nature with associated ecosystem services and cultural" (IUCN 2013) (p.7). By this, it is emphasized that conservation is needed to reach sustainability and that ecological services are major factors of sustainable conservation. The 2004 definition leads to six management categories of PAs, including Strict nature reserve, Wilderness area, NP, Natural monument or feature, Habitat/species management area, Protected landscape or seascape, PAs with sustainable use of natural resources. Due to historical circumstances, the classifying and naming of PAs may differ from one country to another.

Pursuant to the to Vietnam Biodiversity Law 2018, the PAs system is categorized into four categories: NPs, nature reserves, species/habitat conservation areas and landscape conservation areas. A PA consists of functional zones such as no-take zone, ecological restoration zone, service-administrative zone. Meanwhile, pursuant to the Laws on Forestry 2017, PAs belong to special-use forests. Among PAs, NPs have highest biodiversity importance. This type of natural ecosystems is nationally and internationally important, specific to or representative of a natural ecoregion. They are the habitat of at least one endangered species; have special scientific and educational values; and have landscape and unique natural beauty of ecotourism value. Up to 2018, Vietnam has 170 PAs, 31 of which are NPs (Vietnam Administration of Forestry, 2019).

2.2 Multi-scale and web map

Differing from static maps which are designed to be viewed and output at a single scale, digital maps allowing one to change map zooms led to the birth of multiscale map – dynamic maps that display data in different ways across a range of scales. When map scale changes to certain levels (thresholds), map content and its visualization are required to change. Defining thresholds are a crux of multiscale mapping, which is driven by rules of map generalization and characteristics of the subject being mapped. Such maps are authored in ways that they have to ensure visual continuity throughout their scales so that the map can convey spatial information while striking the right balance between the map's purpose and the precise detail of map content. Generalization is not only the suitable cartographic symbolization across the

scale range but also means that at a certain threshold, mapping method could change if necessary. Ideally, those changes are subtle by either privileging the feature density (for larger scale; i.e. information is given per square kilometer) or spatial extension (for smaller scale), to avoid distraction from the map's content and overall message. Therefore, multi-scale mapping requires map-maker a skillful and delicate application of cartographic generalization rules and mapping methods (Van, N. T. P. and Le, M. V., 2016). Figure 1 illustrates the multiscale map of population.

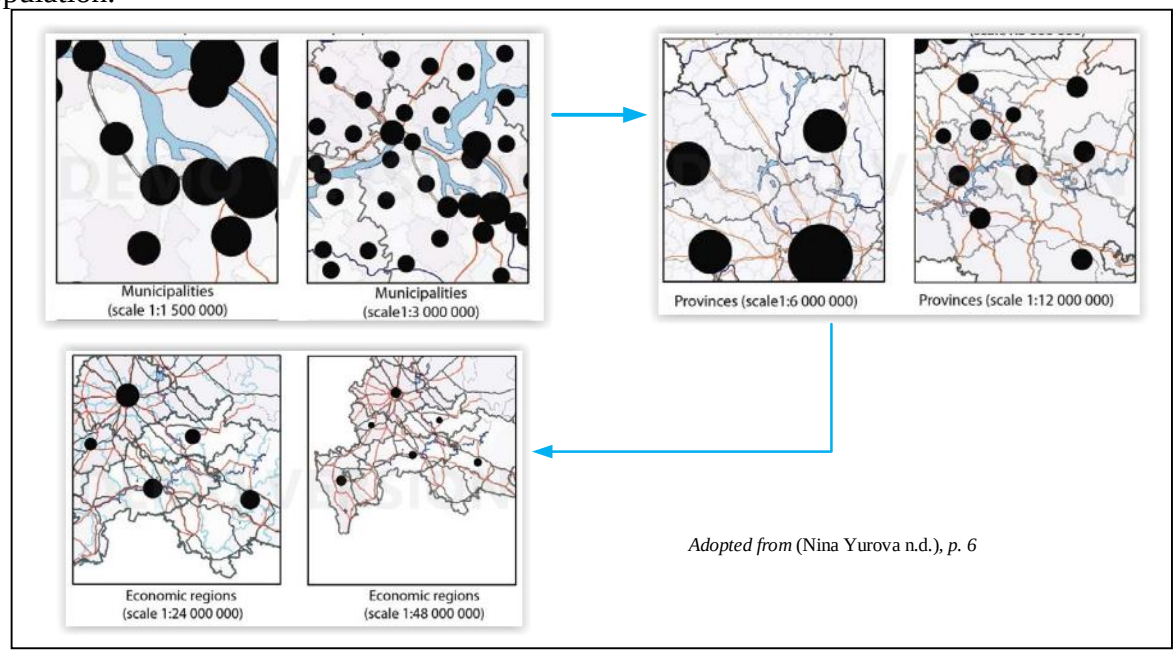

Figure 1. Multiscale map of population

For the last four decades, the multiscale mapping has become among the most prominent and problematic areas in modern cartography. Research work on multiscale mapping includes multi-resolution databases design (multiscale spatial database), real-time generalization, map layer structure, scale-dependent behavior and symbolization (multi-representation). Both multi-scale spatial database and multi-representation are driven by generalization when the map change from larger to smaller scale. The vision of map production is to develop the database that include a single database with the highest needed detail of subject to be mapped, called “master database”. Through technical and technological solutions for automated map generalization, we can derive map on demand arbitrary scales from such a database. Some work on such geographical databases is still in progress. In fact, there is a substitute – the multiscale databases those that contain diverse data sets at different scales, called level of detail (Galanda, M., 2003). Large amount of work had been done on multi-scale database and map layer structure (Dumont, Touya, and Duchêne, 2015, 2020; Frye, 2006; Nyangweso, D. O., 2013). Meanwhile, multi-representation is the changes of symbol, geometry, content and label through scales (Brewer, Sparks, and Raposo, 2012). To a certain extent, the functionality of multi-representation may be supported in spatial databases by storing a collection of pre-designed maps (Zhou and Jones, 2013). Research on multiple representation for thematic maps was conducted with a few mapping methods such as graduated symbol, choropleth, dot density (Mai, T. H. and Lê, M. V., 2017; Yurova, N. snf Samsonov, T., n.d.; Van, N. T. P. and Le, M. V., 2016). Most of those studies are experimented with desktop software and the representation across scales is based on the density of field information.

In the meantime, the Internet has become a trendy medium for cartography. Maps in the internet are interactive and dynamic, which help to easy access and enable adaptation to user’s need with respect to content and scale. According to Harder (2015), web map is online map

that provides ways to work and interact with map layers. It contains a base map with thematic layers, and tools that enable users to interactive with these layers. The interactivities could be basic, such as layer control, navigation (zoom in/out, pan, etc.), adaptive zooming, mouse over effects, click effects, interactive legend; or complex like spatial analysis, proximity…Web maps are shared on the web to work online and on any mobile devices. Therefore, they are accessible anywhere, anytime. In this paper, we present a multi-representation with a collection of pre-designed maps, based on the approach of spatial extension, and illustrate the implementation of multi-representation with web map demonstration.

2.3 Research methods

This study used the empirical research approach. The process of building experiment multiscale map of Vietnam PAs is shown as below (Figure 2):

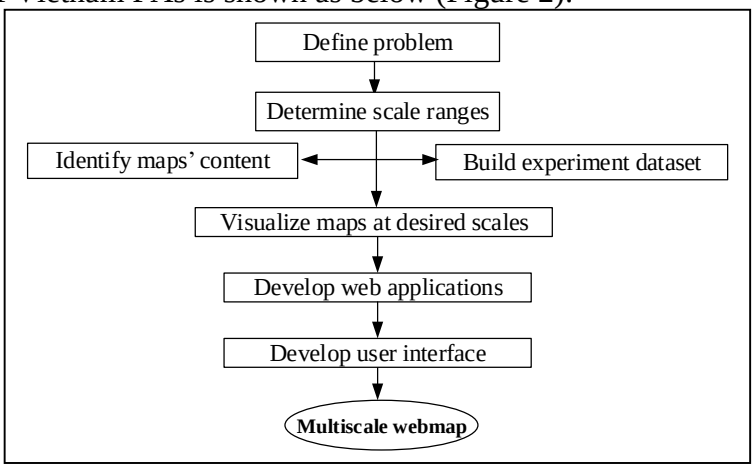

Figure 2. Research design process

According to that, to make multiscale map of Vietnam PAs, firstly, we determined spatial extents intended to be viewed. The spatial extents were set to fit administration levels which spanning from national, regional, provincial to PA level. The maximum and minimum visible scales for each administration level are the full map extent of that level and the full map extent of an adjacent higher level, respectively (Figure 3).

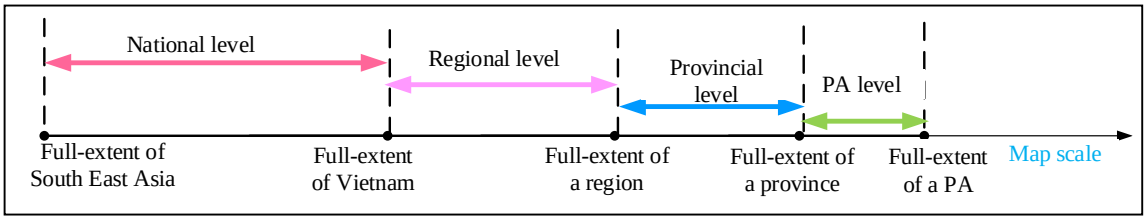

Figure 3. Rules for setting up scale range of multiscale map of Vietnam PAs

Then, we identified the contents for desired maps at spatial extensions, which include the distribution of PAs (national and regional level), of PA functional zones (provincial level) and of natural – socio-economic characteristics inside a PA (PA level). Meanwhile, input data were also collected from online sources, including the World Database on PAs (shapefiles of Vietnam PAs boundaries), Diva-GIS (shapefiles of Vietnam administration levels) and ArcGIS online (PhongNha-KeBang national park or PN-KB NP map package). They are manipulated as needed (i.e. update, re-projection, geometry conversion). Next, we authored pre-defined maps at desired scales. Each single map was designed for best view at the full-extent of an administration units to be viewed and we defined simultaneously symbol transformation across the range of scales to ensure visual continuity at all scales. All composed maps were then ready

to make web map.

Technologically, the web mapping is implemented with ArcGIS platform. Specifically, ArcGIS Desktop was used to build dataset NPs for demonstration and then exported them to ArcGIS Pro. In turn, ArcGIS Pro was used to compose and symbolize sets of pre-defined maps at desired scales. Next, those maps were shared as web layers to ArcGIS online to create and share web maps and ready-to-use web applications (called web apps) which allows to build user interface and interactive tools for exploit spatial information in the cloud. Finally, ArcGIS Experience Builder was used to transform the single-page web apps in a solely place.

3. RESULTS AND DISCUSSIONS

This study created a multi-scale web map of Vietnam PAs. The experiment was conducted at spatial extension of Vietnam, North Centre region, Quang Binh (QB) province and PN-KB NP, within the scale range (Figure 4). Pre-defined maps were conducted with computer screen and designed to be viewed at spatial extension of Vietnam (1:30,900,000 - 1:11.700.000), North Centre region (1:11.700.000 - 1:3.700.000), QB province (1:3.700.000 - 1:900.000) and PN-KB NP (1:900.000 - 1:300.000).

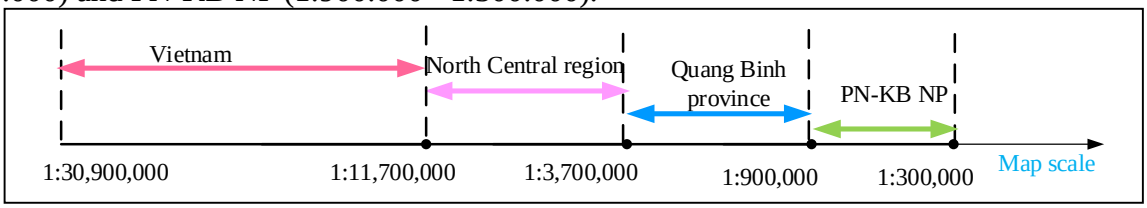

Figure 4. Scale range of experiment datasets

Within the experiment scale range, the content of map varies from the distribution of NPs (Vietnam and North Centre region), of functional and buffer zones of NP-KB NP (QB province), to that of natural and socio-economic characteristics. All contents are symbolized in ways that ensure visual continuity wherever applicable (Figure 5). The web map is held on Esri's GIS cloud and configured with basis interactive tools such as legend display, base-map gallery, layer management, measurement, radius search, selection.

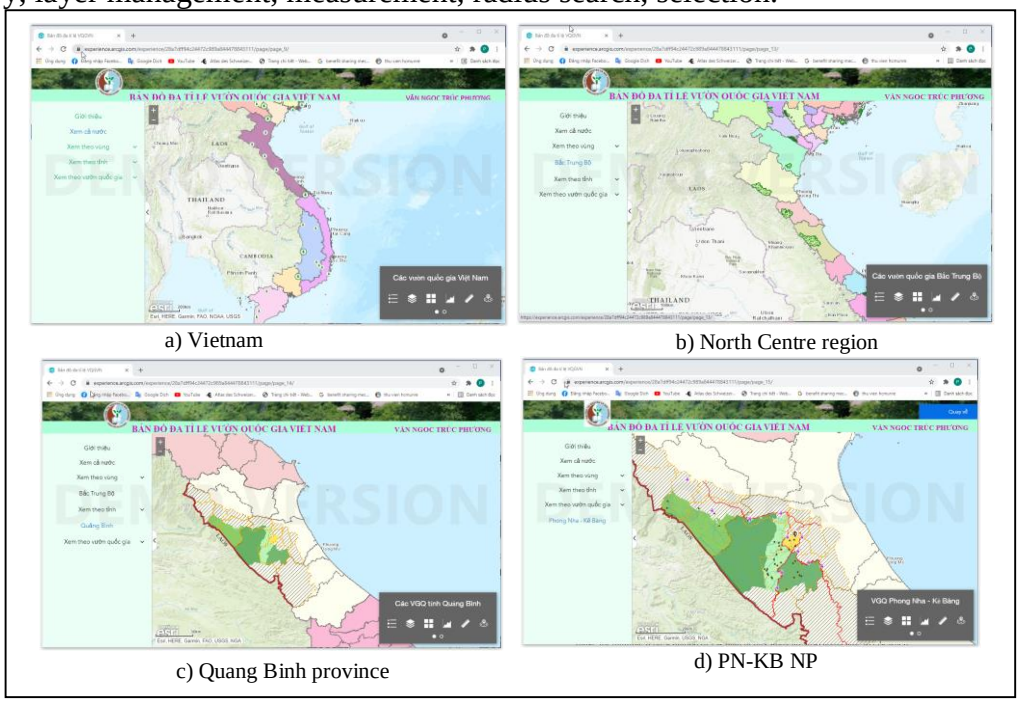

Figure 5. Experiment web map of Vietnam PAs

Through web map services, spatial information of Vietnam PAs is accessible from https://experience.arcgis.com/experience/28a7dff94c24472c989a844478843111. This study proposed rules for setting scale range for multiple representation of PA map. They are reasonable and feasible, but require testing more elsewhere in order to be applicable to other types of PAs.

4. CONCLUSIONS

Increasing awareness, sharing information and knowledge of PAs are key elements for their sustainability. Web map that provides spatial information of PAs has been paid attention. This study is aiming at develop a multiscale web map of Vietnam PAs and experiment with ArcGIS platform. Result is the web map with interactive tools, across spatial extensions, spanning from national, regional, provincial to PA level. The result shows that rules for determining scale range for multi-representation of PA map are reasonable and feasible. However, more experiments need to be done so that the rules can be applicable to elsewhere.

REFERENCES

Brewer, C. A, Sparks, K., and Raposo, P.,. 2012. *Multiscale Design for The National Map 2011/12*

Harder, C. 2015. *The ArcGIS Book: 10 Big ideas about applying geography to your world.* Esri Press

Chu, M. T. 2011. *Xây dựng mô hình đồng quản lý tài nguyên môi trường tại KBT biển Cù Lao Chàm – tỉnh Quảng Nam*. Trường Đại học Khoa Học Xã Hội và Nhân Văn - ĐHQG TP. HCM.

Dumont, Marion, Touya, and Duchêne. 2015. "Adding Intermediate Representations in a Multi-Scale Map to Enable a Smooth Zooming".*CEUR Workshop Proceedings* 1598(c): 15–17.

Dumont, Marion, Touya, and Duchêne. 2020. "Designing Multi-Scale Maps: Lessons Learned from Existing Practices". *International Journal of Cartography* 6(1): 121–51.

Frye, C. 2006. "A Product Driven Approach to Designing a Multi-Purpose Multi-Scale GIS Base Map Database That Supports High Quality Mapping." *AutoCarto 2006*, 1–16.

IUCN. 2013. "IUCN Protected Area Definition, Management Categories and Governance Types". *The International Journal of Protected Areas and Conservation November* (19.2): 2.

Mai, T. H., and Le, M. V. 2017. "Khái Quát Hóa Lớp Nội Dung Chuyên Đề Trong Bản Đồ Thống Kê Đa Tỷ Lệ". *Kỷ yếu hội nghị khoa học và công nghệ 15*, Đại học Bách Khoa - TP.HCM, 145–54.

Galanda, M., 2003. *Automated Polygon Generalization in a Multi Agent System*. University of Zurich.

Neumann, A. 2016. "Chapter 379: Web Mapping and Web Cartography." In Zhou X. Shekhar S., Xiong H. Cham (editors). *Encyclopedia of GIS*. Springer.

Yurova, N., Samsonov, T., ?. *Automatic Selection of Symbols for Diagrams and Choropleths in Multiscale Thematic Mapping*.

Nyangweso, D. O., 2013. *GIS Based Cartographic Generalization in Multi-Scale Environment: Lamu County*. University of Nairobi.

Samsonov, Timofey. ?. *Multiscale Hypsometric Mapping*.

Van, N. T. P. and Le, M. V., 2016. "Thiết Kế Hình Thức Bản Đồ Thống Kê Đa Tỉ Lệ Với Phương Pháp Đồ Giải." *Tạp chí Phát triển khoa học và Công nghệ*, K4-2016 (tập 19): 51–58.

Vietnam Administration of Forestry. 2019. *Báo cáo rừng đặc dụng và phòng hộ Việt Nam 2017-2018.* Hà Nội.

Zhou, S., and Jones, C. B., 2013. "A Multi-Representation Spatial Data Model." *Lecture Notes in Computer Science.*