

**Who owns paradise? Using web mapping to enhance a
geography course exercise about tropical forest conservation**

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Tambopata transformed: Using web mapping to enhance a geography course exercise about tropical forest conservation

Here we present *Tambopata: Who Owns Paradise?*, a map-centric, multimedia website created to enrich an educational role playing exercise about biodiversity, conservation, and development in the Amazon (www.geography.wisc.edu/tambopata). The exercise assigns students a character from the Tambopata region of the Peruvian Amazon, and asks them to evaluate four proposed zoning plans from their assigned perspective. Using principles of web cartography, we designed the four proposal maps to communicate complex information and allow for increased exploration. Compared to the previously used static maps, the website increases opportunities for student engagement with the material, incorporates multimedia, and clarifies spatial relationships and land use patterns. The website is available publicly and can be integrated freely into other university and high school courses.

Keywords: interactive maps; web mapping; role-based visualization; geography education; Tambopata

1. Introduction

Maps are a powerful tool for conveying complex geographic phenomena (Tufte, 1983). Dissemination of maps through the web affords greater accessibility and allows for user-driven interaction (Peterson, 2008), both of which open new avenues for teaching geography with maps. While research into the impacts of interactive, web-based maps on education remains limited, several studies designed to assess the impact of maps for education have shown that students generally prefer using interactive, web-based maps over static, paper maps (e.g. Taylor and Plewe, 2006; Linn, 2007; Fuhrmann et al., 2008). In this paper, we report on our work to bring a geography class exercise onto the web using interactive maps.

The result is *Tambopata: Who Own Paradise?* (Figure 1), a map-centric, multimedia website developed to enrich the student learning experience in Environmental Conservation, a popular geography course offered at the University of Wisconsin–Madison. The website is part of a problem-based learning exercise in which students assume different characters and make decisions about land use activities in the area surrounding the Tambopata National Reserve, located in the Madre de Dios region of southeastern Peru. The activity is based on a real zoning initiative launched in this region of the Peruvian Amazon in 1999. Students navigate through the website to retrieve information about the assignment, to learn about the Tambopata landscape and its inhabitants, and to analyze different land use proposals. The website is available publicly at: <http://www.geography.wisc.edu/tambopata>. The website was designed in such a way that other university and high school instructors can integrate this exercise into their curricula.

2. Background and problem context

Environmental Conservation (Geography 339) is an intermediate-level, four-credit undergraduate course offered every semester by the Department of Geography at the University of Wisconsin–Madison. This course covers the ecological and cultural background of conservation, problems of resource and environmental quality management, and pressing issues of population, food, energy, and pollution. The course draws 170-240 students each semester, making it one of the most popular courses in the Department of Geography. Enrolled students have various academic backgrounds, but most commonly are undergraduates majoring in Conservation Biology, Environmental Studies,

63 Geography, and Zoology. About a third of the students in the class have never
64 taken an Environmental Studies or a Geography course before.

65 In addition to learning about environmental issues in the U.S., students
66 delve into comparative challenges in developing countries. A key theme
67 concerns biodiversity loss and strategies for conserving tropical forests in a way
68 that is fair and practical for local citizens. The course features a four-week
69 participatory zoning exercise based on conservation issues in the Tambopata
70 National Reserve in southeastern Peru. The goal of the assignment is to help
71 students understand different local perspectives of a real-world environmental
72 challenge from a developing country.

73 Tambopata is a frontier area in southwest Peru whose forests are highly
74 biodiverse (Rodriguez and Young, 2000). There are a range of interests
75 regarding the use of the Tambopata National Reserve, including
76 conservationists who want to protect native species and carbon-rich forests,
77 companies that want to utilize Tambopata's untapped stores of gold and timber,
78 and impoverished local people who want to make a living from small-scale
79 agriculture, mining, or forestry within the reserve. Due to these competing
80 interests, Peru's National Environmental Council (CONAM—an agency now
81 replaced by the Ministry of the Environment) initiated a public roundtable activity
82 in 1999. They invited stakeholder groups to propose zoning maps reflecting
83 their interests as a way to come to a consensus on land use regulations in
84 Tambopata. The results have guided management of the region to this day
85 (Naughton-Treves, 2012).

86 This real life roundtable activity was adapted for the Environmental
87 Conservation course starting in the year 2000 to introduce students to the real-

world struggles over land and resources in biodiverse regions experiencing rapid environmental, social, and economic change. The exercise is an example of problem-based learning (PBL), where students learn through solving complex problems in groups rather than through traditional lecture-based instruction. PBL aims to help students develop flexible knowledge and lifelong problem-solving skills in an active learning experience (Hmelo-Silver, 2004). PBL is well suited to geography because the field is interdisciplinary and emphasizes interconnections between topics (Spronken-Smith, 2005). While the benefits of PBL may include a more satisfying student experience and a greater understanding of the material, the risks are increased time commitments for both students and instructors and student discontent over the ‘messiness’ of PBL (Pawson et al, 2006). Nevertheless, the course instructors created the Tambopata exercise to increase student engagement and teach about the complexities of conservation.

More specifically, the exercise reveals the promises and challenges of participatory conservation strategies in areas where institutions have limited authority. Protected areas are the largest deterrent of deforestation in the Amazon (Nepstad et al, 2007), but often are seen as a top-down approach to conservation. Participatory processes ideally allow communities to transparently negotiate rules of access in the protected area in a way that effectively balances conservation and economic development (Naughton-Treves, 2012). Despite inclusive language, participatory conservation can also be used to control public dissent over protected areas or as a political tool to avoid confronting powerful commercial interests (Few, 2001).

In the exercise, each student is assigned a character from Tambopata and must write a position paper drawing from the assigned character's perspective. The character list (Table 1) represents a wide range of perspectives, including loggers such as the powerful owner of 'Madera Grande' (Big Wood), leaders of politically-marginalized indigenous communities (the *Ese'ejá*), ecotourism entrepreneurs, and members of the international community with an interest in Tambopata, such as a biofuel scientist and an energy executive. These characters are based on real participants of the roundtable exercise of 1999, although some characters have been added or altered to expose students to key drivers of tropical deforestation that have not yet reached Tambopata. New characters are added periodically to update the exercise and match current events (e.g., the surge in illegal gold mining in recent years).

Students receive four maps at the start of the exercise, each depicting a different zoning proposal. Then each student must select their preferred proposal based on the interests of their assigned character. The four proposals contain different geographic configurations of nine land use zones: direct use, special use, strict protection, buffer zone, native communities, wildlife & sustainable hunting, tourism & recreation, restoration, and restoration & community reserve. The restoration & community reserve zone was actually an unofficial zone created by roundtable participants, a good example of how the real roundtable was unpredictable and at times ambiguous—an aspect of the exercise that confuses and/or frustrates some students. Students are required to defend their selection in the 3-page position paper based on the website content and outside sources and to participate in a series of in-class

discussions to foster debate and build consensus about zoning in Tambopata. Like the characters, these four zoning proposals are based on actual suggestions offered during the 1999 roundtable exercise.

Since this exercise was first introduced to the Environmental Conservation course, the instructors and teaching assistants have relied on static maps. Students often struggled to distinguish land use zones within each map and reliably make comparisons across the four maps, particularly if they printed color maps in black and white. In the absence of any up-to-date land cover images, students regularly proposed unrealistic land use options. For example, students playing loggers often proposed roadside timber extraction, not knowing that forest had long been cleared from these sites. Another challenge to effective map interpretation for several students concerned scale. Although a simple scale bar was included on each map handout, many students had only limited awareness of the size of the zoning effort and the extent of their characters' extractive activities. This hindered their ability to advocate for certain zones or object to others. More fundamentally, scale ignorance made the exercise feel abstract, as students did not understand if they were negotiating about an area about the size of the city (Madison), county (Dane), or state (Wisconsin) in which they lived. Due to the difficulty in using these static maps, we developed the *Tambopata: Who Owns Paradise?* website using emerging web mapping technology to support a highly interactive and engaging learning experience.

3. Interactive and Multimedia Website Design

The organization of the *Tambopata: Who Owns Paradise?* website logically guides students through the content related to the exercise (Table 2). The

landing, or splash, page of the website (Figure 1), titled *About Tambopata*, provides students with their first look at the Tambopata region (Muehlenhaus, 2013). This splash page also demonstrates the design style that is consistent throughout the website. The background and color scheme have a natural feel to match the emphasis of the exercise on the natural environment. The tattered scroll image behind the text on this page and others with a significant amount of text is meant to play on the metaphor of telling a story to students (Gershon and Page, 2001). Since most students are unfamiliar with this area of Peru, the *About Tambopata* page provides them the location of Tambopata, a sense of scale, photos depicting the area, and text to further orient them to the situation.

From there, students move on to the *About the Assignment* page. This page explains the course exercise and frames the objective: to select and defend the best map for their character. In addition, students are able to download a PDF of the assignment, which gives more details about deadlines, formatting, and specific expectations for the essay and class discussion. This page purposefully includes enough information about the assignment to allow instructors from other institutions to bring the exercise to their classrooms.

Once students are aware of the context of this exercise and the questions they are expected to answer, they navigate to the *Character List*. On this page, students read a description of their assigned character and identify other characters who might be useful allies. Students then move to the *Videos* page, where they learn more about the perspective of their assigned character and the other characters involved in the debate. In contrast to the characters, which are fictional representations of real stakeholders, the people in the videos are real, giving their actual opinions on the zoning and conservation of the area.

187 These videos, first included in the exercise with the launching of the website,
188 helped students to connect with the exercise and their assigned character by
189 stressing that conservation zoning has direct consequence for Tambopata
190 residents. The videos help bring the exercise to life.

191 After students have an understanding of their character's perspective,
192 they finally move on to the map proposals (Figure 2), on the pages *Proposal 1-*
193 *4*. These pages present each zoning proposal individually and encourage
194 students to explore each proposal separately before comparing them in a
195 coincident view (MacEachren et al., 1998). The default view has the extent of
196 the zoned area, with zones overlaid on a Google Maps basemap (Peterson,
197 2008). The pan and zoom functions are unrestricted so that students can
198 navigate within the map to get a better idea of their scale and context (Harrower
199 & Sheesley, 2005). These maps also employ highlighting on mouse-over to
200 allow students to probe for details easily and to support open-ended exploration
201 (Robinson, 2011). When students mouse-over a zone, that zone is outlined in
202 white and the fill color becomes more saturated. In addition, highlighting is
203 dynamically coordinated with the legend using the same highlighting solution
204 (Buja et al., 1996). Finally, mousing-over a zone also updates the text in the
205 upper right information panel to include a description of the zone and the land
206 use activities allowed within it (Figure 3). Another way students are able to
207 interact with these maps is to toggle different basemaps of the area (Figure 3;
208 Roth, 2013). Students are able to choose between Google roadmap, satellite, or
209 a hybrid of the two. This option allows students to understand both the context
210 (using the roadmap) and the actual features of the landscape and land cover
211 (using the satellite map). With this more complete understanding, students will

be able to propose more realistic recommendations for zoning than offered in the past. Students are also able to resymbolize the map by changing the opacity of the zones with this slider, further encouraging exploration of contemporary land cover in the area (MacEachren et al., 1999). The final feature of these maps is a dropdown menu that allows students to overlay their character's location (Figure 3). This feature helps students understand the areas that are likely priorities from their character's perspective.

Once students explore the four map proposals individually, they move on to the *Proposal Overview* page, which allows for dynamic visual comparison of the four maps by placing them side by side (Figure 4; Andrienko et al., 1999). These maps do not allow panning and zooming, as their purpose is to compare the proposals rather than explore them in depth. The title of each proposal links back to the individual proposal page if students want to explore the individual proposals further (Cartwright, 1999). These maps also employ a slightly different highlighting strategy; instead of highlighting on mouse-over, students must click a zone to highlight it. Highlighting in one map is coordinated with the other three maps as well as the legend. This allows students to easily compare which of the proposals has more of the land use zones that their character prefers. We decided to implement a highlight solution on click rather than on mouse-over for persistent highlighting (i.e., selection), an especially important feature if the student is viewing the website on a mobile device and must scroll to see all of the map proposals (Muehlenhaus, 2013). Although we could have allowed quantitative comparison of zones by providing areal measurements, this would not have been true to the original roundtable; the decisions made in 1999 were based on maps that were ambiguous and uncertain.

The final page of the website is the *Credits* page, which names the people involved in the creation of the exercise and the website. This page also provides email addresses so that other instructors interested in using the activity are able to contact the content creators and webpage designers. The bottom of the page includes a disclaimer emphasizing that this is a fictional exercise based on real events.

4. Conclusion

We developed *Tambopata: Who Owns Paradise?* to improve a class exercise about land use zoning and conservation in the Peruvian Amazon, which is now publicly available and able to be used as a module by other instructors. We used principles of web cartography to present this complex situation more efficiently and effectively than with static, paper maps. It is our hope that the interactive maps help the students engage more deeply in the course material and make this unknown place less abstract, so that they are better able to learn about the real-world practice of environmental conservation.

The first class of students used the web application during fall 2013. Overall, students expressed enthusiasm for the application and made good use of the added features. Based on a voluntary, anonymous survey distributed just after the semester, 88% of students reported having a 'good' or 'very good' experience with the website (n=80, out of 189 total students enrolled). When asked their favorite aspects of the website, many students reported the ease of use and organization of the website, the interactive maps, and the videos of real people (33%, 28%, and 13% respectively, n=64). Student feedback will help us improve the website, such as making text more legible, including more videos, providing more details on the area, and allowing students to toggle between

individual maps with their character selected. The website will continue to be updated as the exercise evolves. Possible future improvements include providing a Spanish translation so that Peruvian citizens can use the site. We would also like eventually to upgrade the site so that students could more easily use the maps and associated materials on smart phones and tablets.

5. Software

Tambopata: Who Owns Paradise? was developed using the Leaflet.js web mapping libraries. We chose Leaflet based on its ability to support most interactive map tasks and its ease of learning (Roth et al., 2013). The zoning proposals were prepared as shapefiles using ArcGIS and converted to the GeoJSON format using shpescape.com for mapping with Leaflet. The website complies with HTML, CSS, and JavaScript open web standards, and is simple enough not to require backend database technology. It is hosted on the Department of Geography server at the University of Wisconsin–Madison.

6. Acknowledgements

We would like to thank the following people who supported this project: Eddy Mendoza (CI-Peru) provided us with the original map proposals from the real-life zoning exercise, Nora Alvarez-Berríos (University of Puerto Rico – Rio Piedras) digitized these maps for the original exercise and helped create the content, and Rich Donohue (University of Wisconsin – Madison) provided technical support with Leaflet and Javascript. Funding for an update of exercise content and continued improvement of the website was provided by a College of Agricultural & Life Sciences International Programs (CALS IP) Science Internationalization Course Development Award at the University of Wisconsin – Madison.

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356 Table 1. Characters involved in the Tambopata course exercise.

Character	Brief description of perspective
Brazil nut harvester	Income depends on access to healthy forests
Ese'eja community member	Fears losing rights to ancestral land in the reserve
Colonist farmer	Recently arrived Andean farmer with an informal claim to land
Leader of FADEMAD	Head of the Federation of Agriculturalists in the area
Leader of FENAMAD	Head of the Federation of Native People in the area
Cofounder of Rainforest Expeditions	Ecotourism operator working with an Ese'eja community
Conservation biologist	Concerned with protecting biodiversity
Owner of Madera Grande	Interested in extracting hardwood from the area
Small-scale logger	Has a small logging concession
Gold miner	Long term resident trying to gain a formal mining title
Colonist gold miner	New resident mining informally
Soybean producer	Seeking to bring commercial soybean production to the area
Wisconsin Energy executive	Interested in maintaining large carbon stocks in the forest
Biofuel scientist	Wants to grow biofuels on degraded land

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359 Table 2. Webpage directory of *Tambopata: Who Owns Paradise?*

Page title	Description
About Tambopata	Gives overview information about the area of Tambopata including locator maps and photos, and an explanation of the real-life roundtable activity.
About the Assignment	Explains the course assignment and outlines specific expectations for student deliverables.
Character List	Lists the characters of the exercise, with a description of each.
Videos	Short videos showing the viewpoints of real stakeholders in Tambopata.
Proposal 1 – 4	Four separate pages that each present a map proposal for zoning.
Proposal Overview	Presents all four map proposals side by side for easy comparison.
Credits	Acknowledges people involved in the creation of the exercise and website.

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Figure 1. Landing page of *Tambopata: Who Owns Paradise?*

Figure 2. An example of the default view of an individual map proposal, Proposal 1.

Figure 3. A manipulation of the map showing (a) the highlighting solution, in this case highlighting the zone Tourism & Recreation, (b) a satellite image basemap, toggled from the default roadmap, and (c) a pop-up showing the location of a character, in this case a Gold Miner.

Figure 4. Proposal Overview page, with Tourism & Recreation selected to provide easy comparison of this zone across all four map proposals.