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A Citizen Science Approach for Collecting Toponyms

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Abstract: The emerging trends and technologies of surveying and mapping potentially enable local experts to contribute and share their local geographical knowledge of place names (toponyms). We can see the increasing numbers of toponyms in digital platforms, such as OpenStreetMap, Facebook Place Editor, Swarm Foursquare, and Google Local Guide. On the other hand, government agencies keep working to produce concise and complete gazetteers. Crowdsourced geographic information and citizen science approaches offer a new paradigm of toponym collection. This paper addresses issues in the advancing toponym practice. First, we systematically examined the current state of toponym collection and handling practice by multiple stakeholders, and we identified a recurring set of problems. Secondly, we developed a citizen science approach, based on a crowdsourcing level of participation, to collect toponyms. Thirdly, we examined the implementation in the context of an Indonesian case study. The results show that public participation in toponym collection is an approach with the potential to solve problems in toponym handling, such as limited human resources, accessibility, and completeness of toponym information. The lessons learnt include the knowledge that the success of this approach depends on the willingness of the government to advance their workflow, the degree of collaboration between stakeholders, and the presence of a communicative approach in introducing and sharing toponym guidelines with the community.

Keywords: citizen science; volunteered geographic information (VGI); toponym; crowdsourced data collection; data quality

1. Opportunities for New Approaches to Collect Place Names

Place names (known as toponyms) are an indispensable component of our communication about geographic features or regions, both natural and man-made [1,2]. They serve many purposes, including the obvious need for unambiguous identification for navigation, but also for current territorial claims and managing a society's past (e.g., to compare the renaming of streets or even entire cities following a regime change) [3–8]. Toponyms frequently have deeper meanings, often involving complicated semantics related to language and history [9–11], but many toponyms also describe the features they name. Some example toponyms from Indonesia are derived from folklore tales (Mount Tangkubanperahu, Banyuwangi), historical names (Jakarta from Jayakarta), or names of persons that have been adjusted to the local language (Malioboro from General Malborough, or Sampur from Zandvoort) [12–14]. Other (natural) features can cross multiple linguistic regions, for example, the river "Danube" has several names: "Donau" in Germany and Austria, "Dunaj" in Slovakia, "Duna" in Hungary, "Dunav" in Croatia and Serbia, "Dunav" and "Дунав" in Bulgaria, "Dunărea" in Romania and in Moldova, and "Dunaj" and "Дунай" in the Ukraine [2]. Other toponyms originate from local geographical knowledge and history. Local citizens know places from their personal experiences and collectively agree and disagree in naming the places as part of their daily communication.

When surveying became a centralized and structured activity, the respective naming and mapping authorities (often part of the military forces) would collect, manage, and publish place names in the form of topographic maps, atlases, and gazetteers [15,16], sometimes taking control of local names. As part of this process, place names were standardized (at least within national boundaries) and, in case of ambiguities or multiple names, the authorities would officially approve names at the national level to be a part of a reference for worldwide communication.

In the last decade, the collection of toponyms has changed once again, potentially enabling the local population to have a more significant influence and contribution. The revolution of digital mapping and application allows citizens to contribute online through Web 2.0 technology and platforms, such as OpenStreetMap (OSM), Facebook Place Editor, Swarm Foursquare, and Google Local Guide. The absolute number of openly available toponyms increased due to the increase in crowdsourced and volunteered geographic information (VGI). Government agencies began to realize the potential use of citizens as scientists [15,17–20]. Researchers also explored crowdsourcing and gamification approaches in toponymic survey, place naming, and engaging the public in gazetteer creation [15,18,20–23].

Government agencies or toponymists (experts or researchers on the study of place names, or toponymy) are motivated to try such citizen science approaches for various reasons. One aim is to allow members of the general public to share indigenous or local geographical knowledge of place names. Another is to enable people to contribute to scientific investigation, ranging from data collection through analysis. More importantly, crowdsourced geographic information and citizen science approaches offer new opportunities for developing countries, particularly where existing gazetteers might be less complete, and where constraints on staff and resources are even more severe.

Nowadays, the national agency tasked with naming geographic features in Indonesia has been exploring potential approaches and technologies that can provide leverage for crowd involvement in toponym collection. The Geospatial Information Agency of Indonesia (Badan Informasi Geospasial (BIG)) conducted two pilot toponymic survey projects in 2015 and 2016. They then introduced a toponym data acquisition system in 2016 [24,25]. Usually, toponym collection is conducted in line with topographic mapping projects, and toponym standardization procedures are handled by naming authorities (national and regional committees for the standardization of toponyms) [24,26].

The pilot toponymic surveys were conducted in two distinct regions to examine the advantages of mobile, smartphone-based applications, when compared with GPS handhelds and maps, in recording toponyms. One survey in Yogyakarta (2015) collected toponyms of man-made features in urban areas. Another survey in Lombok (2016) gathered natural and man-made features in each district and region. The initial idea and motivation for the survey projects were to provide additional details or complete gazetteers. Group discussions with people in the field and members of toponymic survey projects revealed that local residents were eager to contribute to and learn about the use and impact of toponym collection.

This paper addresses issues in advancing toponym practice through three investigations. First, we systematically examined the current state of toponym collection and handling practice by multiple stakeholders, and we identified a recurring set of problems. Secondly, we developed a citizen science approach, based on participation, to collect toponyms. Thirdly, we examined their implementation in the context of an Indonesian case study. This research addresses identified problems in toponym collection, such as limited official staff in field surveys, the long procedure of the existing toponym practice, and issues of accessibility to all locations.

The following section addresses the first issue by examining the state of the art and deriving common problems. The subsequent two sections then describe a new framework that is capable of addressing the challenges, and show how the framework can be applied to a concrete, national case study (Indonesia). The last section discusses and summarizes our findings.

2. Current Challenges of Managing Toponyms—Citizens to the Rescue?

2.1. Systematic Evaluation of Challenges in Conventional Toponym Collection

UNGEGN (United Nations Group of Experts on Geographical Names) encourages nations to have national mapping agencies (NMA), or cadaster agencies, or to establish coordinating agencies for the standardization of toponyms in their countries [1,27]. So far, there has been no detailed investigation of the characteristics of UNGEGN countries regarding the coordination and regulation of the collection, or the maintenance and publication of place name databases. We explored the country reports and toponymic guidelines provided on the UNGEGN website to determine the current state of the art in toponym collection and maintenance. We selected documents from the 10th and 11th United Nations Conferences on The Standardization of Geographical Names (UNCSGN) in 2012 and 2017 [28,29]. We used UNCSGN 2012 as the baseline because of the discussion on VGI and crowdsourced geographic information proposed in this conference. From the perspective of data collection and maintenance, public authorities are responsible for collecting and standardizing place names, and publishing place name databases in a national gazetteer.

Our literature study revealed a range of problems encountered by current toponym collection practices. These ranged from high-level legislative framework and organizational issues, to concrete data-handling problems. Traditional toponym data handling typically featured lengthy and costly processing, with considerable delays between collection and publication, which further exacerbated the limits of human resources. Many national naming authorities have realized that crowdsourcing and citizen participation potentially can provide up-to-date and reliable geographic information based on local geographical knowledge. However, a naïve crowdsourcing approach would encounter challenges of credibility, legal issues (licensing, ownership, and copyright), and the sustainability of the system or project. In this paper, we suggest a taxonomy of problems in toponym collection identified from the literature, as can be seen in Table 1.

Table 1. Taxonomy of problems in toponym collection.

Category	Main Problems and Open Issues
Legal aspect	• Licensing, data ownership, and copyright • Data privacy and liability issues
Organizational issues	• The absence of a national naming authority • Coordination between public agencies • Collaboration with non-government sectors • Conflict resolution (potential for conflicts)
Funding	• No dedicated funding • Limited budgeting at local government
Procedures	• Inadequate regulatory procedures for the systematic approval and recording of place names • Insufficient training materials and guidelines on toponym collection • Long procedure, from collection until dissemination, of gazetteers
Personnel	• Limited human resources • Lack of trained staff • Language problems in interviews
Accessibility	• Insufficient transport infrastructure • Limited broadband and Internet services • Poor or bad weather conditions
Data Availability (Output)	• Incomplete place name database • Data uniformity issues (database structure and format file) • Duplicate places • Incorrect type of feature classes • Syntactic (data) integration (history of toponym records) • Semantic integration (meaning of places) • Spatial footprints (point-based location, bounding box (extent of features), and representation of vague places)

The data acquisition cycle can be identified as the main weakness of the processes in traditional toponym collection. For example, the toponym collection and verification cycle in Indonesia are generally conducted every 3 years to cover all 34 provinces for man-made features, except when there is an urgent case or a national priority. There are four main problems that cause this weakness: (1) extended procedures from data collection until dissemination, (2) limitations of human resources, (3) insufficient training materials, and (4) data uniformity issues and completeness. This assessment arises from a synthesis of the reports by governments on the situations in their countries, as presented in the 10th and 11th UNCSGN. If these problems can be tackled through collaborative approaches and using advanced technology, then government agencies can provide improved and complete gazetteers.

2.2. Bringing in the Power of Citizens

Collaboration among multiple stakeholders can be expected to help solve the above-mentioned problems. Several terms are being used interchangeably: crowdsourcing, VGI, or citizen science. A comprehensive review of these terms describes the role of citizens in crowdsourcing geographic information [30].

The term "crowdsourcing" is a combination of "crowd" and "outsourcing", coined by Howe [31]. Crowdsourcing is a process that involves outsourcing tasks to a distributed group of people. The GB1900 project is a successful example of a gamified crowdsourcing approach in toponym handling. Citizens participate online and share their knowledge of places (not only place names,

but also place histories) through the transcription of toponyms and other features from maps on the GB1900 website [22]. The project and approach successfully tackled problems of limited human resources in field surveys.

VGI is defined as "the harnessing of tools to create, assemble, and disseminate geographic data provided voluntarily by individuals" [32]—in other words, geographic information produced by individuals and made available for the public. Public authorities and researchers also explored and tested mobile applications to collect vernacular place names, or urban names, which involved multiple stakeholders in several projects [20,21,33]. However, very little attention has been paid to the role and motivation of people's contribution as toponymists in digital place naming.

Public involvement and engagement in scientific projects is known as citizen science. Citizen science appeared in the mid-1990s, although the practice itself is older. Nowadays, many researchers have explored the definition, utilization, motivation, and typology of citizen science [34–38]. Citizen science projects have become increasingly attractive in natural and social science. People definitely can share their knowledge and receive feedback or obtain added value from it. Citizen science projects are based on volunteering and the contribution of information for the benefit of human knowledge and science [35]. The general public participates in scientific research activities and actively contributes to science. They provide experimental data and facilities for scientists. They raise new questions and help co-create a new scientific culture. They, themselves, become equipped with new learning and skills and receive a deeper understanding of scientific work in appealing ways [39].

The United States Geological Survey (USGS) conducted a successful story from crowdsourcing national topographic maps. The National Map Corps [19] brings future direction to improve and involve citizens collaboratively. National mapping and cadaster agencies in Europe have explored crowdsourcing and VGI approaches to update their topographical features [40]. For example, in Austria, people have contributed through a Web-GIS application and an additional survey conducted using paper-based maps with toponyms [18]. In the Netherlands, historical societies have been involved in the Dutch Kadaster project to improve toponym data as part of the new system of key registers for topography [15]. In Sweden, a crowdsourcing project among the Swedish NMA, Lantmäteriet, and the Swedish municipalities has developed a mobile application to collect toponyms (vernacular place names) and provide new toponym information in urban areas [20,33]. In Great Britain, the public have contributed and used the GB1900 Web application (provided by the National Library of Scotland, Edinburgh, UK) to help historians check and review place names and gather memories associated with places. This Web-based application was developed to collect toponyms and detailed information in old maps, such as base maps [22].

Many studies on VGI, crowdsourcing, citizen science, and geosocial media [18,19,41–43] have shown correlations between the power of where and public contributions. Several studies have shown that VGI and gamified crowdsourcing potentially are useful to collect and enrich (direct or indirectly) place name information. Investigations have studied the relationship between VGI, gamification, and geographic data collection [44]. Towns Conquer was one example of toponym collection using mobile apps. This mobile application was developed to collect vernacular names by updating or validating the existing place name database from the Spanish National Geographic Institute (IGN Spain) [21]. Collaboration between members of the public and toponymists, or a national naming authority, requires careful harmonizing, but this approach has the potential to complement the existing or traditional toponym practices. A legal framework on toponym collection for citizen participation could bring win-win solutions to toponym collection problems. Indonesia offers an example in law enforcement of geospatial information under their Indonesian Geospatial Information Act No. 4, 2011 and government regulations on the standardization of toponyms. The Indonesian government also has continued seeking and developing systems to involve communities or the general public in toponym collection [24].

3. An Approach to Integrate Citizen Science and Toponymy

3.1. Toponym Collection Framework

Following our assessment of the state of the art in toponym practice and crowdsourcing approach, we developed a framework to identify which problems could be addressed by citizen science approaches. In Figure 1, we depict the relationship among toponym challenges, opportunities, multiple stakeholders, and potential approaches. The center is the main goal—collecting toponyms—while the second layer consists of the existing approach and potentially collaborative approaches. The middle layer represents challenges and opportunities, while the outermost layer shows stakeholders. Generally speaking, the national naming authority has a legal mandate and is responsible for providing an accurate and complete gazetteer as authoritative data. The government should provide a legal framework that regulates data availability and organizational issues. Planning, implementing, and evaluating a collaborative approach can be a challenging project, especially for countries that have multi-dimensional problems, such as Indonesia, given its geographical, cultural, and language diversity.

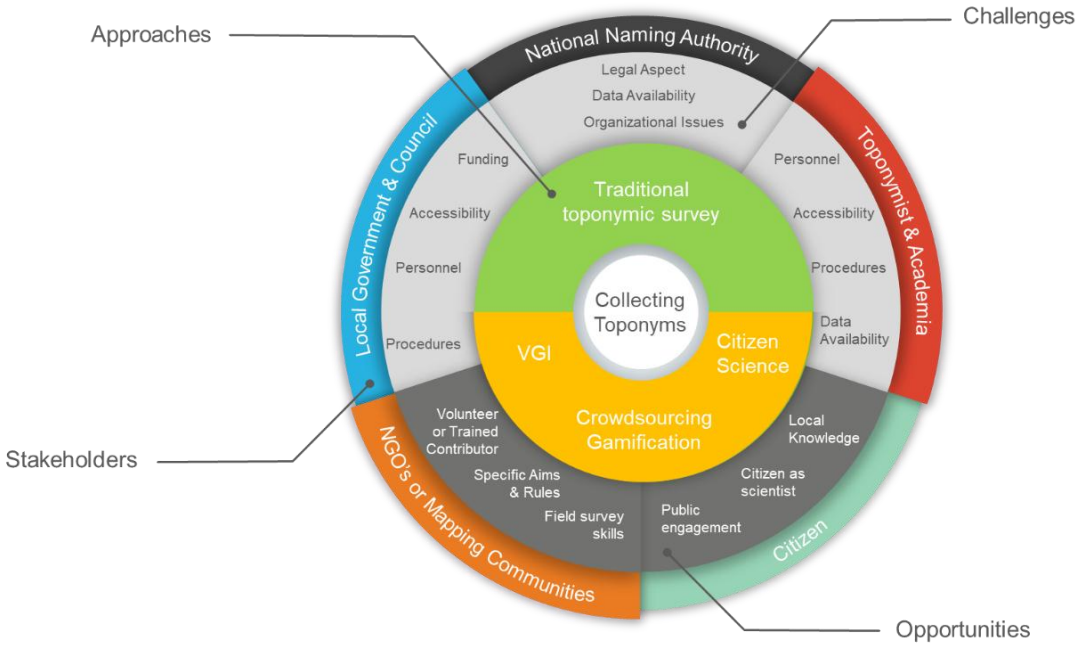


Figure 1. Challenges and opportunities to explore the potential use of a toponym collection approach with multiple stakeholders.

In the current toponym collection setup, a local government and council are responsible for their respective regions. At least four main challenges have to be handled by local authorities: funding, accessibility, personnel, and procedures. Often, there is no dedicated funding for toponym collection, which has to be linked to and integrated with other activities. Sometimes, the members of a regional council cannot approve the budget proposed by the local government, given other priorities in regional planning and development programs. In this case, it is the role of the national naming authority to establish a legal framework as a necessary foundation or reference in providing details, procedures, and budgeting for toponym collection. Inadequate regulatory procedures, especially at regional levels, are one of the challenges. Indonesia consists of 34 provinces and, currently, only one province (Special Region of Yogyakarta) provides a legal framework for place naming. The governor regulation on toponyms established by the Special Region of Yogyakarta provides details on the procedure of place naming to preserve local wisdom and history of place names. Eventually, this regulation may provide a solution to the problems of funding and limited personnel. Local governments can prepare

detailed planning and implementation for fieldwork and training to improve data completeness and personnel capacity. On the other hand, local government can develop their general investment plans to tackle accessibility issues in their region, such as building infrastructure for fast Internet, roads, and bridges.

The quality of data and capacity-building activities might be maintained and improved by involving toponymists, researchers, or students to bridge the gap of information and knowledge of toponyms between local people and the government. They may be collaboratively involved in reviewing place name information from their scientific aspects, such as the writing, spelling, and meaning of place names, and the history of toponym records. However, the number of experts on geographical names or with academic discipline (for example: geography, history, and language backgrounds) interested in toponymy is limited. Sometimes, they have inadequate access to toponym data in rural areas or when trying to deal with problems of incomplete place names or integrate them with the meaning of names and history. Generally, toponymists and academia play an essential role in elaborating the problems associated with limited personnel, accessibility to data, lengthy procedures, and data availability.

VGI and crowdsourcing geographic information provided through digital platforms, such as OSM, Facebook Place Editor, Swarm Foursquare, and Google Local Guide, have indicated the potential resources from non-government organizations (NGOs), mapping communities, and citizens. Their presence also contributes to the documentation of toponyms. NGOs and mapping communities have their specific aims and rules, including procedures, and offer volunteers or trained contributors. OSM community members actively provide spatial databases (buildings, places, and point of interest) for disaster management. Many citizens have the geographical knowledge of places and willingness to share. There is an interesting opportunity for local governments to collaborate with OSM communities and citizens to produce complete toponym data. A citizen science approach for collecting toponyms will provide a more comprehensive place name database and elaborate the limitations on personnel. The emerging technologies offer some advantages, which enable people to contribute and reduce problems associated with the lack of staff. Mobile applications and Web-GIS for toponym data collection have been developed and explored by many researchers and governments [18,20,22,33].

The current state of toponym practice helps us to understand the potential position of advancing a toponymic survey project. We should consider how crowdsourced geographic information and citizen science approaches could tackle problems, such as: the long procedure, limited human resources, incomplete place name database, and integration of syntactic and semantic information. Some citizens are eager and able to enrich place name information. On the other hand, some NGOs and mapping communities in Indonesia are willing to follow the current standardization of toponyms, even though they have their aims and rules.

3.2. Existing Mobile and Web Applications for Toponym Collection

Fieldwork activity in toponym collection is a combination of collecting the geographic location of toponyms and providing textual information into a specific "name form" (questionnaire). Existing mobile and Web applications can help solve the problems of the lengthy procedure from data collection until dissemination, especially if the causes are a lack of trained contributors and limited availability of traditional toolkits (GPS handheld, voice recorder, and camera). The minimum requirements for mobile and Web applications for collecting toponyms consist of nine functionalities: (1) navigation, (2) marking GPS coordinates, (3) tracking, (4) displaying a map, (5) taking geotagged photos, (6) recording audio, (7) other geotagged notes or the ability for the generation of forms, (8) offline functionality, and (9) user-friendly and simple app.

GPS on mobile phones facilitates collecting toponyms because, previously, the availability of GPS handheld devices to be used in fieldwork was severely limited for local governments. Nowadays, there are many mature applications with different kinds of functionalities and navigating features. There are at least two promising GPS and navigation applications available to support

toponym collection. First, there is GPS Essentials (http://www.gpsessentials.com/). This can enable local people to collect toponyms using its user-friendly, simple app and manual (also available in Bahasa Indonesia, developed by a local contributor and distributed through an online community). The second system is Maverick: GPS Navigation (https://wiki.openstreetmap.org/wiki/Maverick). This has offline functionality (use of offline maps and GPS) and a fully OSM-based offline navigation for Android.

Mobile phone applications for geographic data collection have emerged in many types and with many features. For instance, Humanitarian OSM Team (HOT) Indonesia developed Geo Data Collect (https://wiki.openstreetmap.org/wiki/Geo_Data_Collect) by integrating OSMTracker for Android (https://wiki.openstreetmap.org/wiki/OSMTracker_(Android)) and OpenDataKit (ODK) Collect (https://opendatakit.org/use/collect/). EpiCollect (http://www.epicollect.net/) is used by epidemiologists and ecologists, together with citizen scientists, for epidemiological data collection, collation, and visualization [45]. Meanwhile, the Towns Conquer game [21] was developed using Android SDK and ArcGIS SDK on the mobile client side, web services using PHP and SQL Server database on the server side. Another generic system architecture suitable for public participation using free open source software and mobile apps was studied [46,47]. In this system architecture, ODK Collect and the ODK Aggregate modules store data with a PostgreSQL database. EpiCollect and ODK provide functionality for creating forms for data collection. Survey123 for ArcGIS (https://survey123.arcgis.com/) and Fulcrum (https://www.fulcrumapp.com/) offer this functionality for fieldwork, with smart and simple questionnaires to collect data effectively.

There are three possible toponymic survey approaches using advanced technologies: (1) acquire toponym data using GPS Mobile apps, (2) build digital toponymic forms on mobile and Web applications for toponymic survey, and (3) develop new apps for toponyms data acquisition. The first could use a pilot study to focus on how mobile apps address the issues of limited human resources, time constraints, and data completeness. The second project would involve local governments and communities to participate in building the name form on apps. The main idea here would be to build interest and engage with them in the early stages of a toponymic survey project. The third project would require an evaluation of the urgency to develop new apps (based on evaluation of the two previous projects) and to evaluate the existing mobile and Web applications developed by the naming authority.

These three proposed projects might not solve some problems immediately, for example, the legal aspects, organizational issues, and funding. On the other hand, this kind of approach can increase general public participation and cover areas not exposed yet in national or regional programs. However, the use of a citizen science approach and the coordination among stakeholders are crucial to citizen motivation and contribution.

4. Indonesian Pilot Studies

4.1. Understanding Stakeholders in Toponym Collection

We argue that, in Indonesia, the organizational setting of toponym collection problems (see Table 1) is closely related to both the top-down and bottom-up approaches in decision-making and policy implementation. The national naming authority is focused on the learning process to manage these two approaches. They conduct annual meetings to get people at all levels actively involved by providing information, suggestions, and ideas to the policymaker. This organizational structure is shown in Figure 2. In a top-down approach, national naming authorities have the responsibility to initiate and set up the principles, policies, and procedures. Capacity building through training on toponyms is established by the national naming authority in coordination with local governments at the provincial level. The participants of toponymic training from the village, district, regency, or city level depend on the agenda of the training. In a bottom-up approach, local governments from villages and subdistricts

up to district or city levels have the task of bringing all local actors to work together in order to promote and preserve local geographical knowledge of place names.

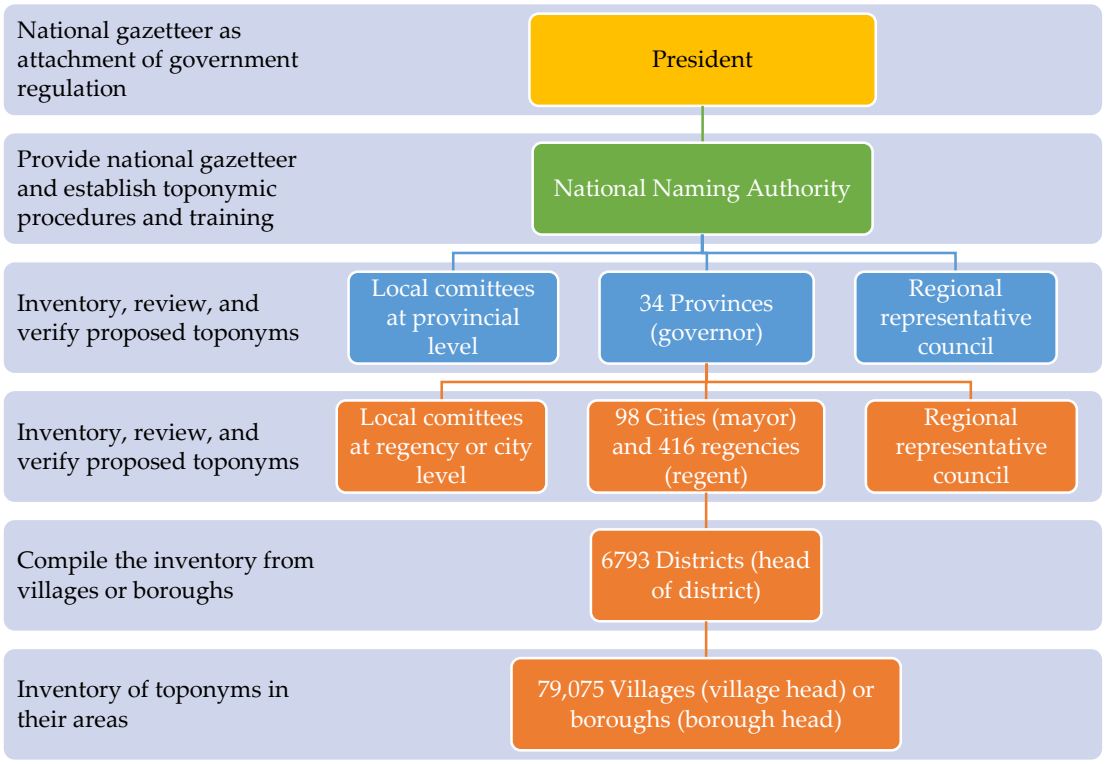


Figure 2. Organizational structure of public authorities for the standardization of toponyms in Indonesia.

Next, we examined toponym collection in Indonesia using stakeholder analysis. The main goal was to identify multiple stakeholders and learn their characteristics using data from interviews and observations during toponymic training and collection activities. We assigned scaled values and relative ranking in the measurement of interest and influence. Examples of questions and answers (Q and A) were:

- Q1: In few words, how would you describe the toponymy and toponym collection?

  A1: Toponymy is study of place names, while toponym collection is activity conducted by government or citizen to collect place names in their region and register the list of place names to naming authority.
- Q2: Do you know which institution is involved in local toponyms committee? Mention a few of the institutions if you know the information, regional and planning agency.

  A2: Yes, I know. Institutions in local toponym committee may consist of the governance bureau at regency or city level, head of district, and cadastral regional office.
- Q3: Are you ready to become a part of toponym committee or technical team to support the field survey?

  A3: Of course, I am ready because it is part of my task as official staff in the governance bureau.

  From interviews and observation results, we categorized the responses into ranks; an example being:

  3 = Has great interest and is ready to become involved and contribute in the workflow
  2 = Has the willingness to become involved, but does not know the procedure
  1 = Not interested

According to the existing organizational structure of toponyms practiced in Indonesia, the inventory of toponyms is conducted at the village and subdistrict level and coordinated by local committees on toponyms at district or city levels. After the inventory and review, the proposed toponyms are submitted to the higher level to be verified. In practice, this mechanism has not worked smoothly because of the lengthy bureaucratic procedure and limited budgeting at the local government level. The technical team or data collector and surveyors in topographic mapping activities provide toponym data to be used in the verification process. The stakeholder analysis matrix in Table 2 summarizes our investigation on the current constraints or findings, including their interest and potential influence in toponymic survey projects.

Table 2. Stakeholder analysis matrix.

Stakeholder	Motivations, Constraints, and Findings	Interest in Toponym Practice	Influence in Toponym Practice
Head of government (national to local level) [1]	Not interested in details, just results	Medium	Medium
National naming authority	Internal coordination (between public agencies)	High	High
Regional representative council	Lack of information on toponym practice	Low	Medium
Local committees	Budgeting and human resources	Medium	High
Surveyors [2]	Lack of skills and knowledge	Low	High
Traditional leaders	Frequent language barrier	Medium	High
Local residents	Expect to promote their neighborhood	High	High
Academia	Not entirely interested, it depends on the expertise	Low	Medium
Non-government organizations or mapping communities	Specific rules and platforms	Medium	Low

[1] President, governor, mayor/regent, head of district, village or borough head. [2] The technical team (data collector) at the local committee or surveyor in topographic mapping activities.

The Indonesian national naming authority remains committed to tackling the problems on toponym collection through seminars and toponymic training for local committees and relevant stakeholders. Nowadays, they also use media gatherings to promote issues and achievements of toponym collections in Indonesia to journalists. The next step is to optimize coordination among multiple stakeholders and crowd (citizen) participation.

4.2. Toponymic Survey Projects and Development of Toponymic Data Acquisition System

The pilot studies were conducted in two different regions and involved different participants. The first pilot study in Yogyakarta Special Province involved undergraduate students from Universitas Gadjah Mada (UGM)—Indonesia and provincial government. The second pilot study in Lombok Province involved provincial government and communities.

Table 3 presents the basic elements and steps of toponymic surveying. Planning was the first element, with the purpose to define the schedule, coverage of the study area, estimation of workload (volume, time, personnel), proposed methods, and work distribution. Then, a preliminary survey was conducted to establish communication and coordination with the local government, acquire permission and support letters down to the village level, and decide on the location for a base camp during the fieldwork. Data preparation consists of preparation of manuscript/printed maps and secondary data

(such as points of interest and administrative boundaries from the local government). The participants in the Yogyakarta survey were 16 staff members from BIG and UGM. They were divided into eight teams of two surveyors each. Fieldwork was conducted in Kecamatan Gondomanan, Kota Yogyakarta. This location was selected because it has famous and historical buildings, such as the Fort Vredeburg Museum (official Indonesian name, Museum Benteng Vredeburg Yogyakarta), the Presidential Palace (Istana Yogyakarta or Gedung Agung), and Malioboro Street. The toponymic survey was conducted from 21 October 2015 to 26 October 2015, and was followed by data entry, editing, and compilation in the office. Every day, each team discussed and shared some suggestions to improve the quality of fieldwork. Based on their daily evaluation, the most challenging part was communication and data handling.

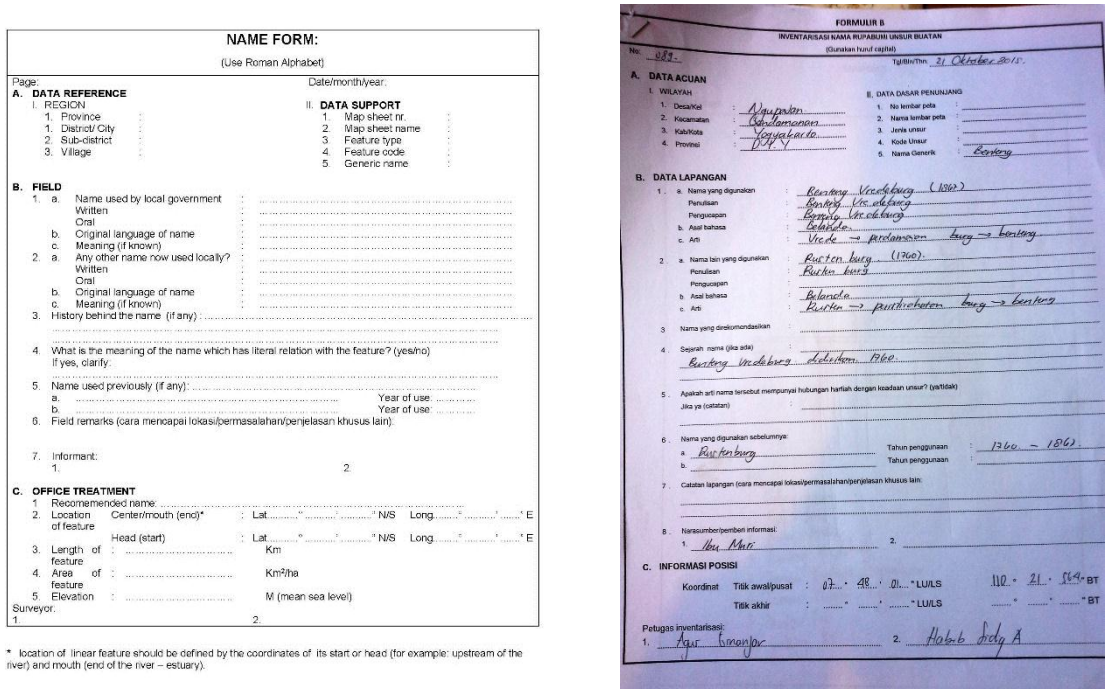
Table 3. The elements and steps of toponymic survey projects.

Elements	Steps
Preparation	Planning Preliminary Survey Data preparation
Fieldwork	Recording toponyms Interviews with local people
Office Treatment	Data entry and editing Data compilation
Verification	Review of place names Approval of place names
Data Publication	Create gazetteer Publish (printed and digital) gazetteer

In the region, most local residents spoke Javanese, even though several respondents could speak in Indonesian. In this case, UGM undergraduate students acted as translators during interviews. Each group was equipped with a GPS handheld (or mobile device with GPS navigation apps), camera, map, and name form for recording toponyms. It was optional for each group to use mobile devices, because GPS navigation apps were explored for the first time in this project. The geographical name form is shown in Figure 3. The national naming authority provided this (in a paper-based format) for recording detailed information, i.e., the place name used by the local government, alternative names, and more, including the meaning and the history of the name (if any). All data were recorded and compiled in GIS shapefile format.

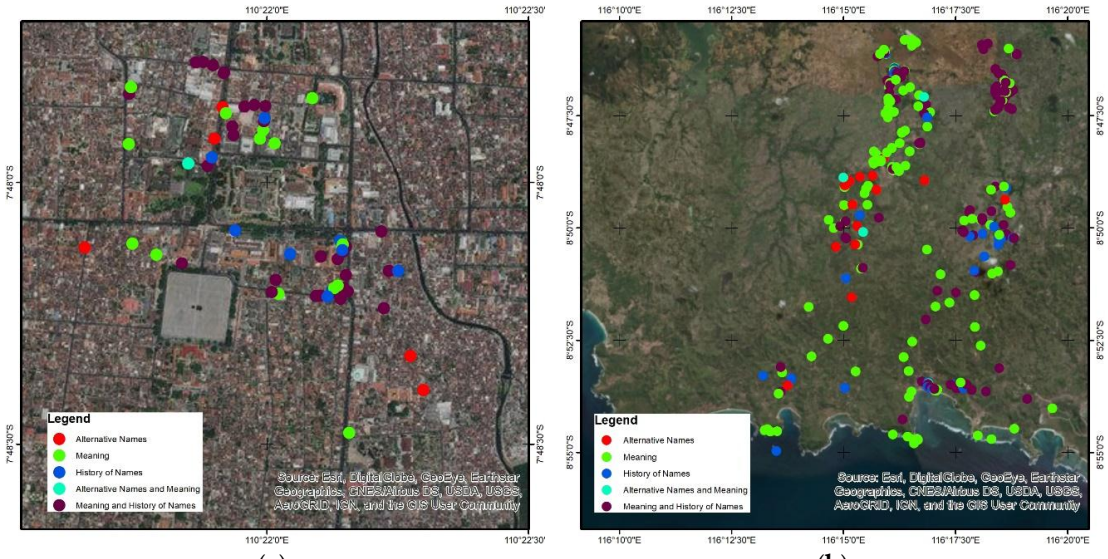
The participants in the toponymic survey project in Yogyakarta were only able to collect 63 place names with information on their history, meaning, and alternative names from a total of 743 features (Figure 4a). It was difficult to interview or select a person who fully understood the meaning and history of each place. Support and coordination from the local government of the Special Region of Yogyakarta could probably help increase data completeness. Unfortunately, the local government was unable to support the survey adequately due to time constraints. However, in the preliminary survey, communication and coordination with the local government were done as part of the procedure.

Based on the preliminary survey, we improved the involvement of the local government and the community, as well as the equipment (tools and data management). The second survey was conducted in Kecamatan Pujut, Kabupaten Lombok Tengah, West Nusa Tenggara Province. We prepared 33 sheets of manuscript maps (with high-resolution satellite images at the scale of 1:5000). The surveyor team in this project consisted of eight persons from BIG and eight persons from the local government.



(**a**) (**b**)

Figure 3. Names form used by the national naming authority (NNA) in Indonesia: (**a**) an example of the "Name Form" for collecting toponyms in the field; (**b**) complete name form from fieldwork in Yogyakarta. (Courtesy of Badan Informasi Geospasial).



(**a**) (**b**)

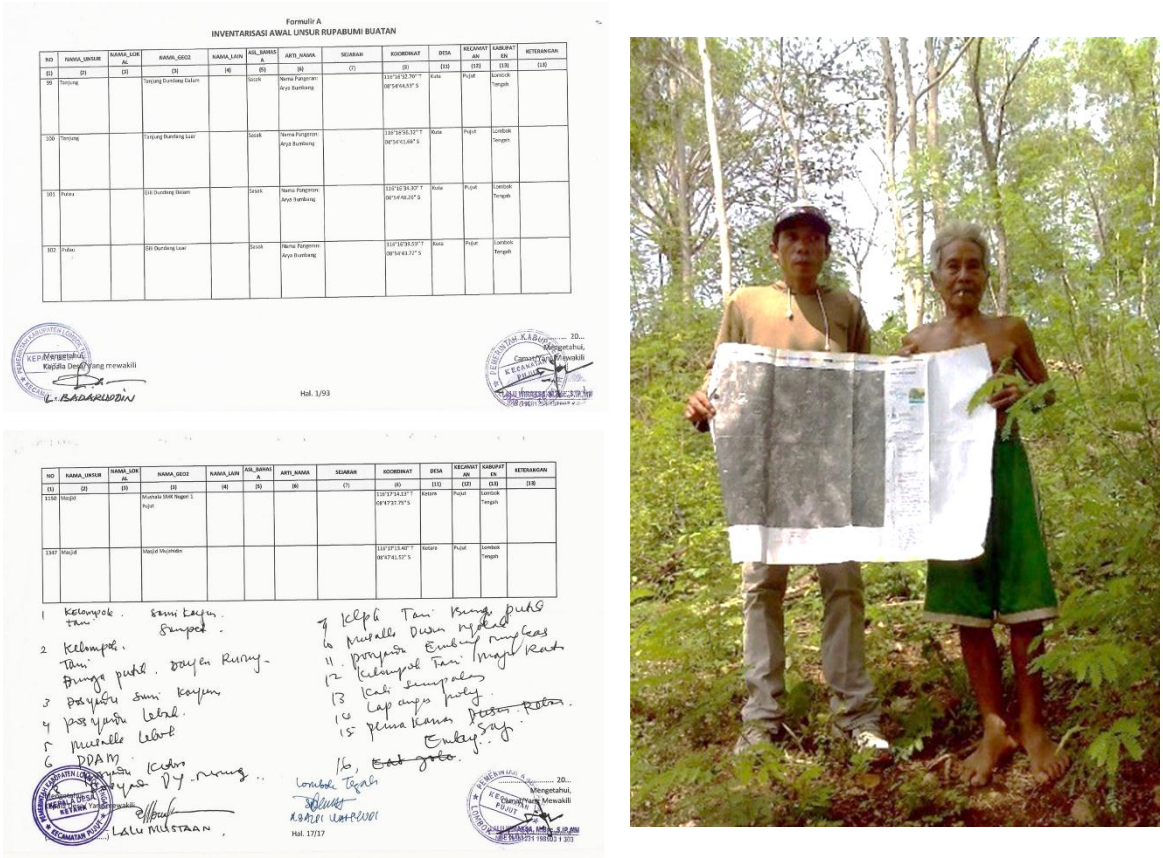
Figure 4. Toponyms with alternative names, meaning, and history of names: (**a**) urban names in the case study of Yogyakarta provided 63 toponyms; (**b**) natural and man-made features in the case study of Lombok provided 367 toponyms.

Three main steps were conducted and improved in this survey: (1) collection and data entry, (2) verification with the local authority, and (3) data publication. A field survey was conducted for 11 days, from 24 September 2016 to 4 October 2016, by eight teams. Each team covered areas from three to six maps, depending on the characteristic of the region. Each team conducted data entry in the period from 30 September 2016 to 5 October 2016. In contrast to the previous project, the surveyors

managed their data in Geodatabase file format and attached photos to this database. From a total of 1484 points collected in the Lombok project, only 367 place names had complete information on alternative names, meaning, and history behind the names (Figure 4b).

Data from the two pilot projects showed an increase in the number of data completeness due to the involvement of the local government and community in the second pilot project. In the first pilot project, we had ~8% of information about history/meaning/alternative names, versus ~25% in the second pilot project.

The verification process involved local people from the village (at least two local authorities or informants, usually the head of the village and traditional leader), subdistrict, and district level (Figure 5). To speed up the verification process, and based on the accessibility of villages, the team was divided into six groups. Each village representative checked place names in the compiled name forms and their geographic locations. The traditional leader and head of the village had the local geographical knowledge. They knew about the geography, history, and meaning, or possibly mythology, of places (if any).



(**a**) (**b**)

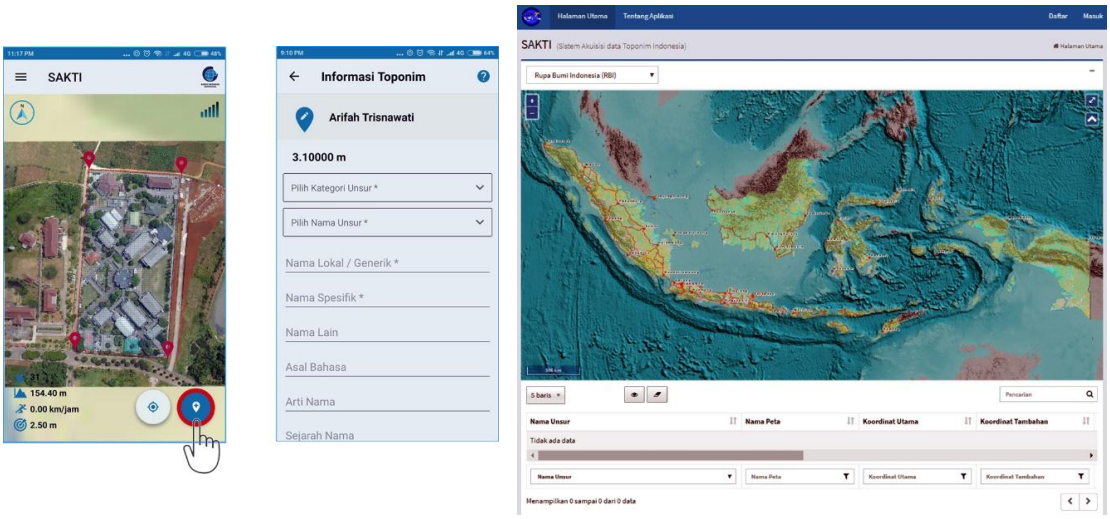
Figure 5. Verification process in the toponymic survey in Lombok: (**a**) compilation of place names with approval from local authority; (**b**) respondents (local people) share their local geographical knowledge and put place names on the map. (Courtesy of Badan Informasi Geospasial).

These two pilot projects used existing GPS tools and navigation apps in the Android market, including GPS Essentials and Maverick GPS Navigation. The functionality of these GPS navigation apps was helpful if surveyors were navigating without a data connection and new to and unfamiliar with the study area. It also made the survey activity more effective and efficient. Data collected can be saved as notes in the apps with geographic coordinate location and geotagged photos. The result from GPS navigation apps can be exported to GIS format file and processed to the next step in gazetteer

creation. Nowadays, local governments do not depend on the minimum availability of GPS handheld, voice recorder, and camera. They can use mobile phones supported with navigation apps to collect geographic location, record pronunciation, and take geotagged photos.

Competition between the teams in these two pilot projects was encouraged to maintain their motivation and improve the quality of data collected from fieldwork. Achievements calculated were based on working capacity (extent of the area of survey covered per day), data completeness, and difficulties in finding respondents and data management. Generally, the limiting factors were accessibility to location, weather, and density of geographic features in fieldwork areas. On the other hand, mobile applications could improve the surveyor's performance and increase public participation in the field surveys.

The national naming authority in Indonesia developed a toponym data acquisition application and introduced it in 2016 at an initial stage. According to the Indonesian report at the 11th UNCSGN (Eleventh United Nations Conference on the Standardization of Geographical Names) meeting in New York in 2017, the goal of developing the mobile app, called SAKTI (Sistem Akusisi Data Toponim Indonesia/Indonesian Toponymic Data Acquisition System), was to collect toponyms and send the data collected directly to the Badan Informasi Geospasial server [48]. Recently, in April 2018, BIG promoted and launched the new version of SAKTI mobile and Web-GIS applications (http://sakti.big.go.id/sakti/webgis/) to local governments in toponymic training for capacity building. The development of SAKTI sets out to standardize the procedure and database derived from field survey by local government (Figure 6). The benefit of the SAKTI mobile and Web-GIS applications are: (1) user-friendly and simple app, (2) displaying map (online base map provided by BIG), (3) effective (paperless and minimized error in writing coordinates), (4) safe (reduced risk of lost or damaged data in fieldwork), (5) standardized database (data structure based on standard toponymic database from BIG), and (6) time (expected to be faster than using paper-based survey). SAKTI mobile and Web-GIS applications do not provide sufficient offline functionality, but these applications have fulfilled the rest of minimum requirements for collecting toponyms. In the current version, the users should have an Internet connection to log in at the first attempt before beginning to collect toponyms.



(**a**) (**b**)

Figure 6. Selected screenshots of SAKTI (Sistem Akusisi Data Toponim Indonesia/Indonesian Toponymic Data Acquisition System): (**a**) "Name Form" for collecting toponyms in the field in SAKTI mobile application; (**b**) SAKTI Web-GIS (http://sakti.big.go.id/sakti/webgis/).

However, there is a limitation in this toponym workflow using mobile and Web-GIS applications developed by BIG regarding crowdsourced data. It is still limited to official staff (surveyors) who have to upload a letter of assignment from an authorized official or local committee. Users with

guest accounts can use the apps, but they cannot submit their data to the server. To date, we cannot evaluate data collected from SAKTI because the introduction to local governments and the toponymic training have not been completed yet. It is expected that, by the end of 2018, SAKTI mobile and Web-GIS applications can provide toponym information and be used effectively by local governments to improve the toponym collection cycle in Indonesia.

5. Discussion and Recommendation

The first project in Yogyakarta faced problems in data management and post-fieldwork office treatment to produce gazetteers. Time management and realistic calculation of the capacity of human resources need careful consideration in the preparation step. Learning from Yogyakarta, the project in Lombok was equipped with guidelines and work plans for each team, including communication with stakeholders. Introduction and training on toponymic surveys were conducted before the actual fieldwork. In both projects, we could collect place name information on alternative names, meaning, and history of names for ~8% to ~25% of cases accompanied by agreed upon names between local residents and government.

Interviews and discussions with people involved in this project provided additional insights on problems. New ideas or strategies also suggested the need for more focused toponym collection and collaboration among stakeholders. From a technical perspective, mobile data collection and free open source software, such as QGIS, would be helpful to work with place-based geographic information and data management. The two main reasons why local government used free open source software were: (1) their cost-effective or cost-saving nature, as sometimes they have no dedicated funds to purchase commercially licensed software, and (2) the flexibility to use free open source software alongside any operating system and computer hardware.

We need to consider existing constraints, such as working time and staff members. Then, explore the willingness for contribution from citizens. The upcoming project will consider an evaluation of the previous toponym projects and establish more contributions from local people (the power of the crowd) as toponymists. The lessons learned from the Indonesian case studies for the development and fieldwork implementation include: (1) we have to start citizen science projects in other areas, and examine and prepare comparison analysis for improving the outcomes; (2) gamified citizen science can be a good means to maintain participant motivation and engage with different difficulty levels during data collection, analysis, and publication of toponyms, as the examples in Section 2.2 showed; and (3) we need to develop ways to ensure toponym collection can be more fun and, thereby, motivate the contributors, for example, by applying game theory elements.

Toponym collection and handling conducted by a national naming authority that has to involve local people as scientists is challenging. The new paradigm of a collaborative approach requires governments to adjust their usual business workflows. There are various types of problems and levels in toponym data handling and management. Several of the more developed countries already have focused on enriching their gazetteers, while developing countries are still dealing with trying to ensure that they have a sufficient base coverage of their entire territory. Conflicts of place names happen for various, and often particular, reasons, and in specific areas, for example, those associated with political or social issues or territorial ownership.

Recording alternative names, meaning, and histories of toponyms provides additional insights into place name information, as can be seen from our Indonesian case studies. A citizen science project on toponyms is open to a wide range of contributors and multiple stakeholders, and toponymists or national naming authorities are eager to establish a well-developed workflow and guidelines. Communication and technical skills to gather meaning and historical information of places and to manage spatial information needs to be improved. Local people would like to participate by marking and recording their places in Web or mobile application. In this sense, gamified toponym collection is a potential method of the toponymic survey to solve several problems at once, such as lack of human resources, tools, and data management.

In future work, we will investigate two types of toponymic survey projects. First, the collaborative project conducted by working together with government, scientists, and citizens. In this project, we will design data collection methods and develop digital forms of place name questionnaires. Second, we will evolve the co-created project as an independent toponymic survey conducted by mapping communities or local people. Some of the members of the public have actively handled a toponymic survey from the beginning until the end of the project (data publication). Overall, key aspects to a successful toponymic survey project are the willingness of the government to adapt their workflow, for collaboration between stakeholders to improve, and for a communicative approach to evolve in introducing and sharing toponym guidelines with the communities.

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