Web GIS Development for Minangkabau Customary Village: A Case Study of Padang Lua Village, West Sumatra, Indonesia

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Abstract

Minangkabau is a cultural and geographical entity embracing matrilineal kinship system. The descendant line is taken from the women's side of a family. The customary land is inherited by women, while the men are only allowed to peruse it. Customary land may not be traded, but during an emergency may be mortgaged. In Padang Lua, as well as other villages in Minangkabau, various problems with social conflict potential have arisen due to conflicts against Minangkabau local custom which involves land and house sale. To reduce social conflict and support 'smart village', a Web GIS has been developed in Minangkabau villages using Free Open Source Software (FOSS), i.e. PostgreSQL/PostGIS, PHP, and JavaScript. This paper reports Web GIS development. The method utilized in developing Web GIS is Research & Development. The Web GIS database is designed to follow the regulations that separate ownership of customary land and houses as well as regulations related to other landowners in Minangkabau. The Web GIS aids village heads/officers as well as prospective land and house buyers to find information on the following aspects: 1) land status, and location, and its owner; and 2) house owner and its occupants as well as land on which the house is located. The Web GIS has demonstrated its ability to reduce social conflicts related to land and house trade in Minangkabau community.

1. Introduction

Padang Lua is a Minangkabau customary village located in West Sumatra Province, Indonesia. It is located at the entrance to Bukit Tinggi Tourist City, therefore the village became a bustling village and grew into an economic center. Rural development is growing rapidly as exhibited in new building construction such as banks, health centers, schools and other facilities. As a result of rapid development, the population from surrounding areas migrated into Padang Lua. Land and house sale, possess potential to cause social conflict. Social conflict potential rose as customary land codes had not yet been incorporated into Indonesian agrarian regulations. Indonesia possesses 23 customary regions. Each region possesses respective land tenure rules (Abdulharis et al., 2007). This complex customary land tenure system is influenced by Indonesian geography. It is an archipelago consisting of 17,504 islands. In 2011, Indonesia is populated by the customary population of 70 million people (Arizona, 2013). Therefore, land disputes are common in customary regions, especially Minangkabau (Tegnan, 2015 and Mutolib et al., 2015). To address this problem, land administration

services need to be improved using information technology (IT) applications, in accordance with local customs rules and at the lowest government level, i.e. village government level (Samborsky and Popiv, 2015 and Bydłosz, 2015). IT application provision will encourage smart villages establishment (Ranade et al., 2015).

One of the vital services that ought to be available in the smart village is land and house administration registry (Viswanadham, 2014). Unfortunately, land administration registry services are available in city/ regency government level instead of in villages. On the other hand, government policy had demanded the populace to register their land, despite having not implemented local custom in the policies (Manaf, 2009 and Arizona, 2013). As a result, customary lands (in Minangkabau it's called *harta pusaka tinggi* or high ancestral property) are registered as a personal possession (in Minangkabau it's called *harta pusaka rendah* or low ancestral property). Houses on the customary lands are not owned by the registrar or landowner instead, it's owned by the family/tribe. In Minangkabau, a group of family or tribes reside in a

parcel of land. With this process, the customary land is traded or used as mortgaged in lending money from banks (Manaf, 2009). Should the lender could not pay their debt, the bank would then confiscate mortgaged land and sell it to another party. The mortgaged land buyer does not know they bought land is, in fact, customary land, nor did they know where to request such information as well. Village head is not involved in trade/bank moneylending. Land Institute, which releases land certificate does not record land's history. As a result, disputes arose among the populace which led to riots and physical clashes in villages (Astuti, 2011 and Mutolib et al., 2015).

A centralized information system of land administration services, house, and its' occupant is an important aspect for Padang Lua and other villages in Minangkabau, as well as other customary regions in Indonesia, even in various countries in this world (Peters, 2013, Bottazzi et al., 2016 and Locher, 2016). Nevertheless fore mentioned information system need to adhere to local custom. A number of endeavors have been conducted previously, such as such, study and modeling of customary land tenure systems integrated into the national land tenure system (Abdulharis et al., 2007, Hendriatiningsih et al., 2009 and Guspriadi and Andrayani, 2015). But the system has not been completed and social conflict still occurs in villages (Astuti, 2011, Mutolib et al., 2015 and VanderEng, 2016). This research aims to solve the mentioned problem in lowest government level, which is village level. The Minangkabau local custom is integrated into administration services as business regulation implemented directly into database and application programs. By using this administration service, village head/officer could find existing land status, ownership, and existing populace in a quick manner. Should the prospective land buyer inquire village head/ officer, they could offer their assistance. Populace residences could also be monitored properly. This adheres to Shukla's statement (2016) that a smart village "... knows all information about its citizens...".

Information Technology (IT) capable of integrating, processing, and displaying data (spatial and attribute) on Padang Lua land, house, and its occupants are required in order to solve existing problems. Required IT is GeoInformatics covering Geographic Information System (GIS), Global Position System (GPS) and Remote Sensing (RS) (Sinha et al., 2010, Soytong and Perera, 2014 and Yang et al., 2015). It is in accordance with Ooi et al. (2014) and Ranade et al. (2015) statement, that Geospatial data and GIS are required components in establishing smart villages. Saving, processing, and

visualizing spatial data such as land and house data could be performed by utilizing GIS (Sangwan and Komal, 2016). The first step of developing a village using GIS is making a spatial database of the house and its occupants (Tongco, 2011). In developing the application, Ranade et al. (2015) and Sreekanth et al. (2016) suggested web GIS technology usage in order to integrate existing data. Taiwo et al. (2016) stated that web GIS technology has several advantages; some of which are great processing ability, and spread and visualization of spatial data/information in the form of a map that a million users are able to access the technology anywhere and anytime. Even for accessing cadastral information, Taiwo et al. (2016) explained in their study that both general and professional users prefer this web GIS technology. Based on the studies, Web GIS development of the Minangkabau Customary village is in accordance to IT development in developing villages. On the other hand, Web GIS development is a challenge as it conducts land management in the villages as the lowest level of government (Bydlosz, 2015).

Therefore, the research objectives are described as follows: 1) to build a database on land and house referencing on geographic position and adhere to the Minangkabau local custom; 2) to build Web GIS program modules capable of displaying information on land, house, and its occupants in order to reduce social conflict as a result of land and house trade.

2. Research Method
The method utilized in developing Minangkabau customary village's Web GIS is Research & Development (R & D). In developing The Web GIS, conducted activities are described as follows: 1) analysis, 2) database creation, 3) design, and 4) implementation. Analysis activity is reviewing Minangkabau local custom and related research on the subject. Based on analytical activities, the system requirements were determined and the initial work of database creation could begin. Therefore the system design could be conducted. System design focused on database and Web GIS module creation. The database created is spatial and attributes database consisting of 7 tables, i.e. land, house, owner, landowner, house owner, family, and population. Land spatial data (polygon) were obtained from the Agam Regency Finance and Asset Management Agency (ARFAMA) and Agam Regency Land Institute (ARLI). House spatial data (polygon) were obtained from field surveys in Padang Lua, which were digitized using Google Map. Tables' data attributes were obtained from the Padang Lua Village Head and field survey. The Output of system design is changed into the form of

database and web GIS modules. For the creation of web GIS databases and modules, FOSS was used, i.e. PostgreSQL/ PostGIS, PHP, JSON, and JavaScript. Google Maps was utilized to visualize data inside the database. PostgreSQL with PostGIS spatial extension module is one of the FOSS databases for GeoInformatics (Owolabi et al., 2015 and Choosumrong et al., 2016).

Furthermore, land and house databases, as well as web GIS modules, were examined. Case study's location (Padang Lua) is exhibited in Figure 1. The Padang Lua Customary Village is located in Banuhampu District, Agam Regency, West Sumatra, Indonesia. The coordinates of the village office are latitude -0.341569 and longitude 100.381729. The Padang Lua village has a population of 6783 people, consisting of 3,385 men and 3,398 women. There are 1493 lots of land consisting of 769 lots for residence/house and 724 lots of agriculture.

3. Land Ownership in Minangkabau

The first step in the study was running an analysis towards documents related to land ownership in Minangkabau. The documents involved indigenous history, kinship system and the law of inheritance in Minangkabau. The following is the result of the analysis.

Winstar (2007) postulated that Minangkabau is a unique ethnic group because they have a tradition called *merantau*, when adolescence leaves his or her family to study or work in another place allowing him or her to be independent and matrilineal family system. This matrilineal family system, a system in which mother inherits lineage and ownership of the family's property, was developed by Dt. Perpatih and Dt. Ketemanggungan. The matrilineal system has existed before the Islam entered Minangkabau, even before Hinduism and Buddhism entered Indonesia. However, Hinduism/ Buddhism did not have a strong influence because the teachings are not in accordance with the indigenous tradition of Minangkabau where people learn from nature (Ramayulis, 2010).

Moreover, Ramayulis (2010) stated that Islam entered Pagaruyung Palace officially after King Anggawarman became a Moslem and all Minangkabau people followed his religious practice. Since then, Islam has been the basis for the establishment of the government agencies, such as *Raja Ibadat*, *Raja Adat*, and *Raja Alam*. The following was the fusion and harmony between Minangkabau tradition and Islamic teaching. Ramayulis (2010) explains several stages in the merit between Minangkabau tradition and Islamic teaching, namely 1) custom and religion were not affecting one another using the indigenous philosophy of *adat basandi alur, syara' basandi dalil*; 2) both tradition and Islam demanded mutual rights without changing either one using the philosophy called *adat basandi syara', syara' basandi adat*; and 3) a consensus between the tradition and Islam in Bukit Marapalan, Tanah Datar developed the following philosophy, *adat basandi syara', syara' basandi kitabullah*.
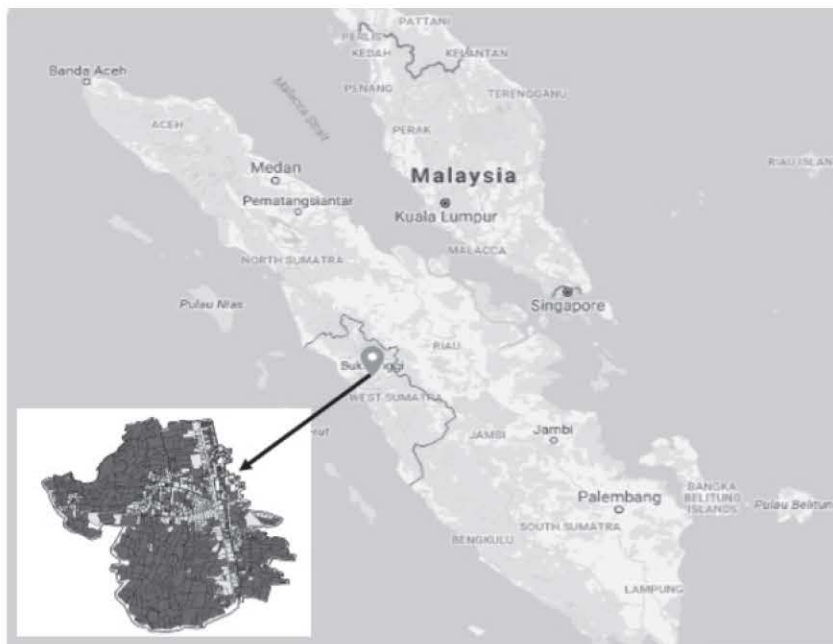
Figure 1: Padang Lua customary village

With the consensus between Minangkabau tradition and Islam in Bukit Marapalan, a meeting where representatives from the entire group of Minangkabau community were in attendance was conducted in Bukittinggi on May 2 to 4, 1952 (Winstar, 2007). Winstar (2007) stated the meeting resulted in the following description:

1. *Harta Pusaka Tinggi*, refers to a) possession belongs to the family/tribe, b) possession was inherited from generation to generation, c) the ancestor was the one responsible for the piece of possession, and d) all members of the family/tribe maintain the possession. This type of possession was inherited based on the indigenous law (*hukum adat*).
2. *Harta Pusaka Rendah* refers to possession owned by a member of family/tribe from his living. This type of possession can be traced easily. Islamic rule is the basis for inheriting *harta pusaka rendah*.

Having run in-depth analyses towards the documents related to land ownership in Minangkabau, Rosmidah (2015), Hanifuddin (2015), Ramayulis (2010) and Winstar (2007) draw the following conclusion:

1. Ancestral property is divided into *harta pusaka tinggi* / customary land/ high ancestral property and *harta pusaka rendah* / low ancestral property;
2. There is a fine line between customary land and house;
3. Ownership of customary land or house is divided into ones belong to a family, tribe, village, and an individual;
4. Customary land is passed down based on maternal lineage, from a grandmother to a mother to her daughters. The ones responsible for maintaining *harta pusaka tinggi* are *mamak kepala waris* (leaders of a family) / *penghulu* (leaders of a tribe) / *kepala desa* (head of the village).
5. Customary land is inherited by several individuals, has right of use, its ownership may not be shared by other people and it may not be sold to others;
6. To overcome economic issues, customary land may be mortgaged;
7. Customary land may not be passed down to individuals outside a family/tribe, for example to the family/tribe of a husband (customary land from the wife's side of the family) or family/tribe of a wife (customary land from husband's side of the family);
8. Indigenous family/tribe refers to one having customary land; when a family/tribe has no possession towards customary land, it is considered as immigrants.

The result of the analyses, all of the Minangkabau custom rules, is implemented into the database to eliminate social conflict resulting from land and house sales. The database developed based on the Minangkabau local rules is the finding of the study. Section 4, system design, elaborates how the database is developed. Rules 1, 3, 4, 6, 7, and 8 have influenced towards design or attributes of the land and ownership table, rule 2 described separation between the customary land, house and their own table, while rule 5 affects the relational design, relationship between the land table and the owner table as well as between the house table and the owner table. The land and house tables are connected using ST_Contains of PostGIS spatial function which means which houses are located on a parcel of land. The system is different from the system in Malaysia or Singapore (Rosmidah, 2015), which is a house in one parcel of land has the same owner and therefore house and owner table are not necessary. In Minangkabau, a house and parcel of land where the house is located may have different owners.

4. System Design

The basis of web GIS database design for the Minangkabau customary village is a land table obtained from ARFAMA and ARLI. The land table is a spatial table covering land ownership data. The land table needs to be split into two tables: Land table and Owner table. Due to the fact, the relationship between these two tables is N to N, then the linkage table is made between Land and Owner tables (social tenure relationship), which is a landowner table. Primary keys of three tables are as follows: 1) land_id attribute set for the land table, 2) owner_id attribute set for owner table and 3) land_id + owner_id attributes are set for landowner table. Furthermore, Land table and Owner table were modified and adjusted to local custom.

Minangkabau local custom regarding land and house were applied to database design. The customs are described as follows: 1) landowners with indigenous and *rantau* (indigenous people immigrating to another city) status: a) their tribe is given the tribe's value in Padang Lua, b) all land status (high ancestral property/low ancestral property) can be owned and c) should they possess high ancestral property, then its tribe must be equal to tribal land; 2) landowners with immigrant resident status: a) tribe is assigned as 0 value and b)

their possessed land is low ancestral property; 3) should owned land is high ancestral property, then the status of the land ownership is village land, tribal land, or family land and tribal land is given tribe's value in Padang Lua 4) should the land status is low ancestral property, then the status of the land ownership is private property rights and tribal land is given a value of 0.

Based on the Minangkabau local custom, the following attributes were added in Land table: 1) land_status (low ancestral property / high ancestral property), 2) ownership_status (family land, private property rights, tribal land, village land), 3) tribal_land, 4) laborer, 5) mortgaged_land and 6) pawn_holder. Figure 2 shows records of Land Table. In Owner table the following attributes were added: 1) resident_status (indigenous, *rantau*, immigrant) and 2) tribes. The land Owner table contains land_id and owner_id attributes. Several more tables for the purposes of monitoring the house and its occupants were added to the web GIS system. The added table is House table with house_id as a primary key attribute, Family table with family_id as a primary key attribute, Population table with population_id as a primary key attribute, and House Owner table correlating House table and an Owner table with house_id + owner_id as a primary key attribute. Minangkabau local custom on properties are inserted into the House table, i.e. 1) if the house is on high ancestral

property, then the house owner is an indigenous (or *rantau*) and the owner's tribe must be the same as the tribal land; 2) If the House table is not connected to the Owner table through House Owner Table, then the house belongs to the landowner where the house is located. ST_Contains of PostGIS spatial function is used to find a parcel of land where a house is located. The developed spatial database supports the relationship that one house was built on several different plots of land through ST_Intersect of PostGIS spatial function. However, such data do not exist. The proposed Entity Relationship Diagram (ERD) design to support Minangkabau custom rules can be seen in Figure 3.

To reduce the social conflict due to customary land and house sale, three main modules of Web GIS were designed to generate information on the following factors: 1) land-based on owner_id, information displayed includes information of the landowner and owned lands, land location, and houses; 2) house based on house_id, information displayed includes house owner, location, family register, and its occupants; 3) land list based on tribe, land status, resident status and mortgaged land status. Three major web GIS modules work on a database built based on Minangkabau local custom. The process or algorithm used by the three Web GIS modules can be seen in Figures 4, 5, and 6. The algorithms are the findings of the study.

Output pane

|	land_id character varying(18)	land_status character varying(1)	ownership_status character varying(1)	tribal_land character varying(1)	laborer character varying(20)	mortgaged_land character varying(1)	pawn_holder character varying(20)	lat double precision	lng double precision
1	130606003900101310	1	1	1		1		−0.341863621428573	100.381618185088
2	130606003900101320	1	1	1		1		−0.341913389529163	100.381511653958
3	130606003900101330	1	1	2		1		−0.341902128815163	100.381758025174
4	130606003900101340	1	1	1		1		−0.342038849731972	100.38178035662
5	130606003900101350	0	2	0		1		−0.342192227586583	100.381881623757
6	130606003900101360	1	1	1		1		−0.342028694839129	100.381950690063

Figure 2: Records of Land Table
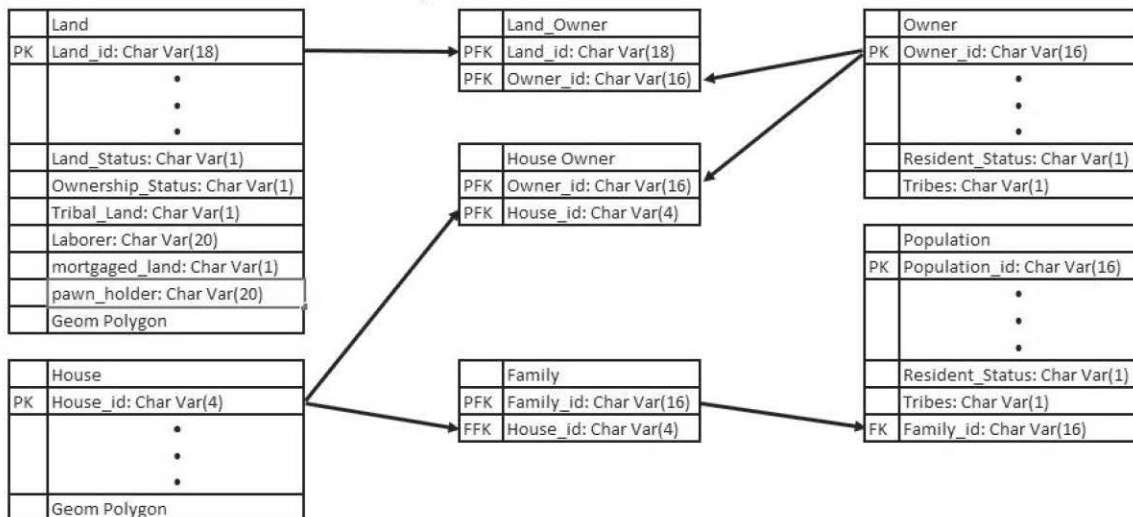
Figure 3: ERD Web GIS design to support minangkabau local custom

Input owner.
Retrieve owner information for owner_id = owner in Owner table.
Take all id_land for owner_id = owner in table Land Owner and save in table A.
For each record in table A
    Retrieve the land information (spatial and attribute) in the Land table based on the land_id = A.land_id
Loop.
Show existing information.
Done.

Figure 4: Web GIS land tenure module algorithm

Input no_house.
Retrieve house information for house_id = no_house in House table.
Perform Contain spatial operations from spatial data Houses_id = no_house in House table with Land table and retrieve land information (land number and status).
Take all family_id for house_id = no_house in the Family table and save it in table A.
For each record in table A
    Retrieve population information on the Population table by family_id = A.family_id
Loop.
Show existing information.
Done.

Figure 5: Web GIS house module algorithm

Input Xtribe, Xland_status, Xmortgaged
Input Xstatus_occupant
Retrieve all records from the Land table and save in table X
If Xtribe <> "ALL"
    Then take all the records from X of tribal land = Xtribe and save on table X.
If Xland_status <> "ALL"
    Then take all the records from X of land status = Xland_status and save in table X.
If Xmortgaged <> "ALL"
    Then take all the records from the X of mortgaged land = Xmortgaged and save on table X.
Retrieve all records from Owner table and save in table Y
If Xstatus_occupant <> "ALL"
    Then take all records from the Owner table that the resident status = Xstatus_occupant and save in table Y.
For each record that is in table X
    Retrieve all owner_id for X.Land_id = land_id in table Land Owner and get name information related to owner_id earlier in table Y.
Loop.
Show information gained.
Done.

Figure 6: Web GIS land listing module algorithm

5. Findings and Discussion

Web GIS for Minangkabau customary village has been successfully developed. The database of the web GIS and The algorithm used by the three Web GIS modules are the findings of the study. The database follows the regulation that separates ownership of customary land and houses as well as other regulation related to land ownership in Minangkabau. The web GIS display is shown in Figures 7, 8, 9, 10, 11, 12, 13, and 14. Web GIS development used PostgreSQL/PostGIS database, PHP, JSON, and JavaScript. Google Map is used for map visualization. Web GIS User Interface is made simple and user-friendly. Users who are not experienced in GIS can use it well. Figure 7 represents Web GIS opening menu that displays Padang Lua village map. The Web GIS main menu consists of Home, Map, Land Tenure, House and Land List.

Figures 8 and 9 exhibits Web GIS Land Tenure module outputs. Both concepts answer to the user's need for information regarding land ownership and location. Users (prospective land buyers) would then perform a transaction with a landowner. Prior to the transaction, a user requires information if the land is owned by the seller? If so, is the land status a low ancestral property? Is land location indicated by the seller true? Suppose the seller is Padma Utami as an indigenous. Based on Figure 8, Padma Utami possesses two parcels of land and their location is shown in Figure 9. However, all the land status she owns is the high ancestral property of Payobadar tribe. According to Minangkabau custom rules, the high ancestral property should not be traded. By knowing the land status owned by Padma Utami, User cancels the land purchase transaction.
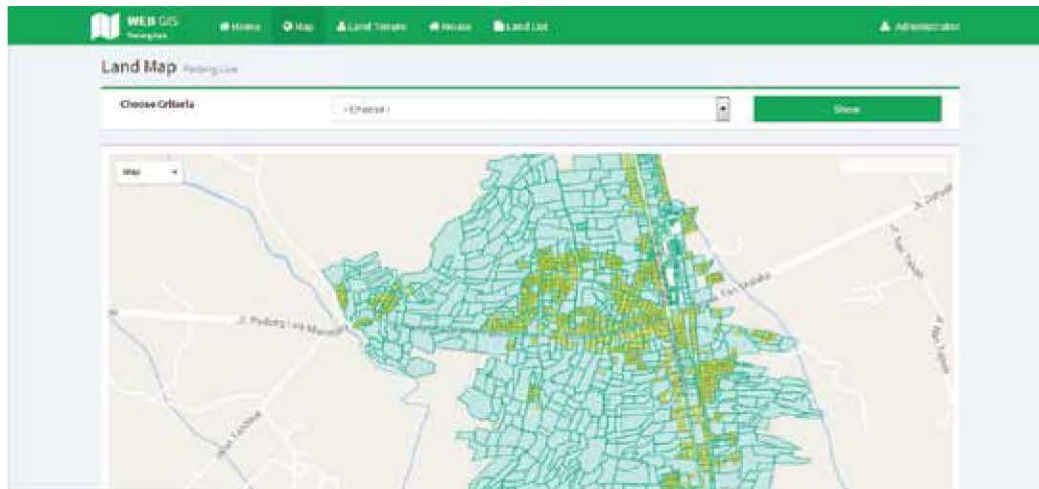
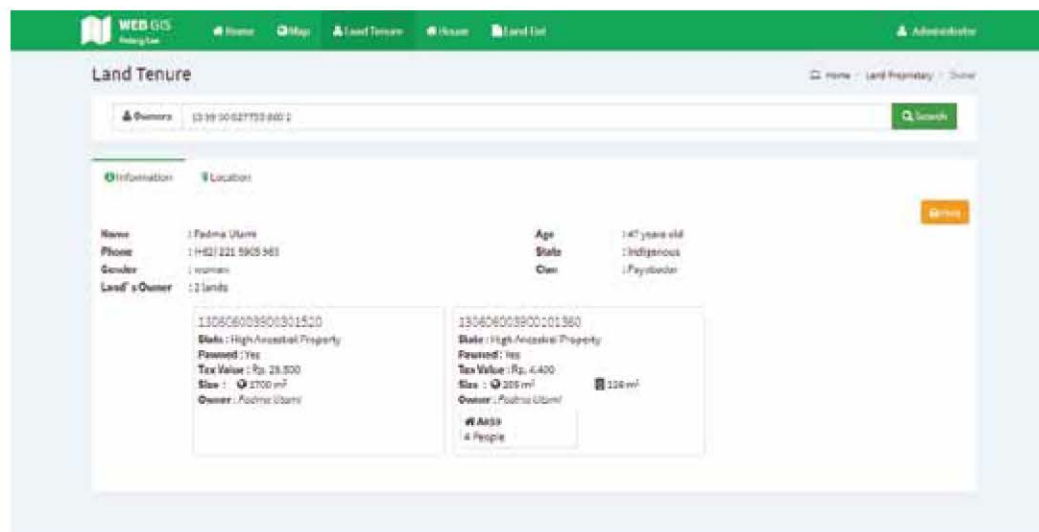Figure 7: Web GIS opening menu for minangkabau customary village

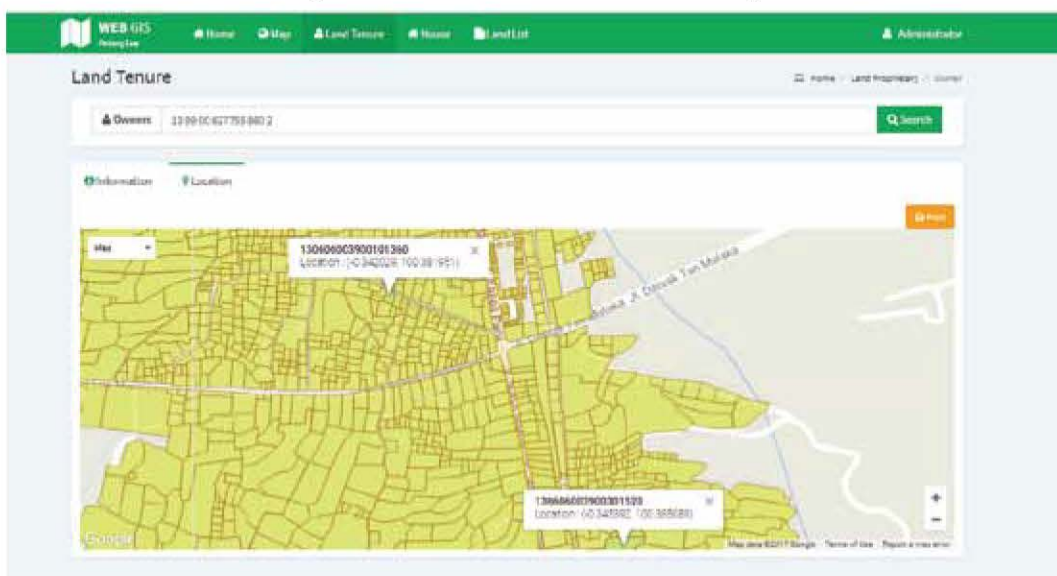Figure 8: Web GIS land tenure module output

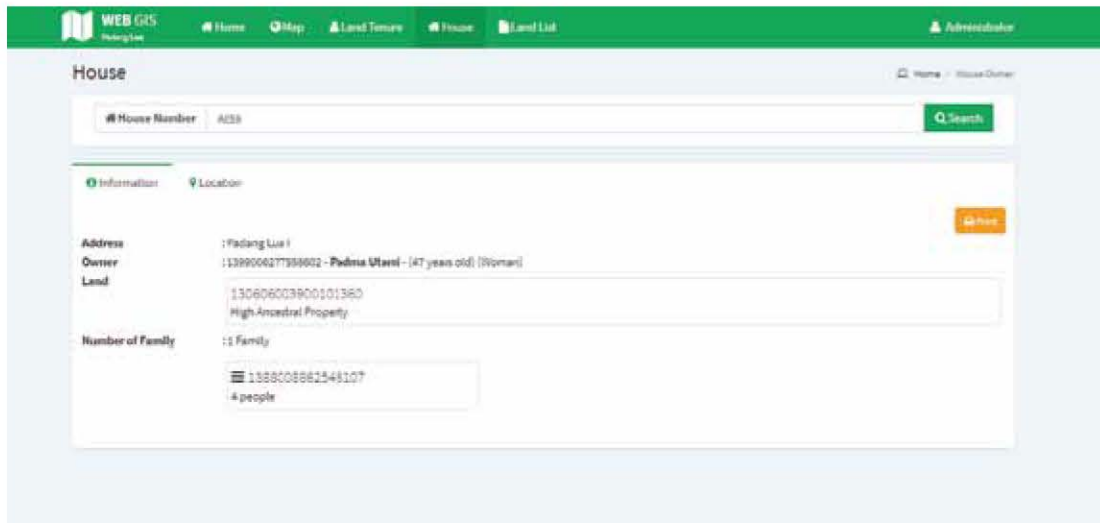Figure 9: Web GIS land tenure (location) module output
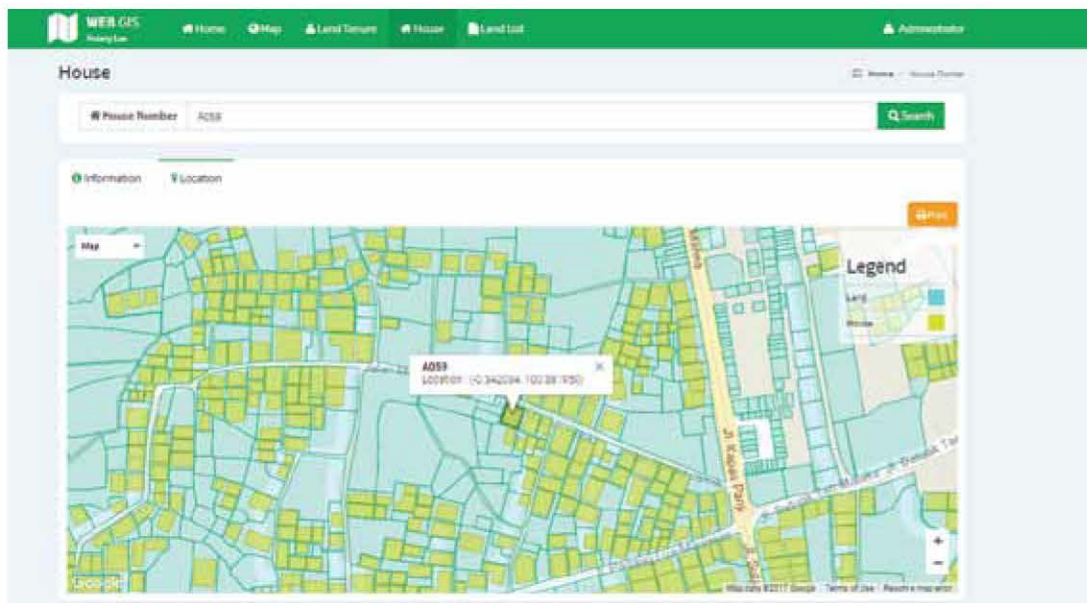
Figure 10: Web GIS house module output

Figure 11: Web gis House (Location) Module Output

Web GIS house module output can be seen in Figures 10, 11, and 12. These outputs help the user in determining house owner, house location and its occupants. These outputs are required by the village head/clerk to monitor owner of a house, location of a house and its occupants. Whether they are native or an immigrant. Based on Figure 10, house no. A059 belongs to Padma Utami and is on high ancestral property land. Figure 11 shows A059 location. A059 is occupied by a family of 4. Members of the family of 4 people are exhibited in Figure 12. Everyone who lives in the house is native of Payobadar tribe. Based on these outputs, village heads/officers can monitor the ownership of houses, their locations, and their occupants.

Figures 13 and 14 are the output of web GIS Land List module. It responds to the need to identify landowners based on tribe, land status, resident status and mortgaged land status. These outcomes are indispensable for monitoring land ownership. By setting options to view salayan tribe, it will exhibit lands owned by the salayan tribe. High ancestral property land status exhibits high ancestral properties owned by the salayan tribe. Indigenous resident status exhibits properties owned by indigenous people. This output-generating program module is useful in finding land ownership under various criteria.
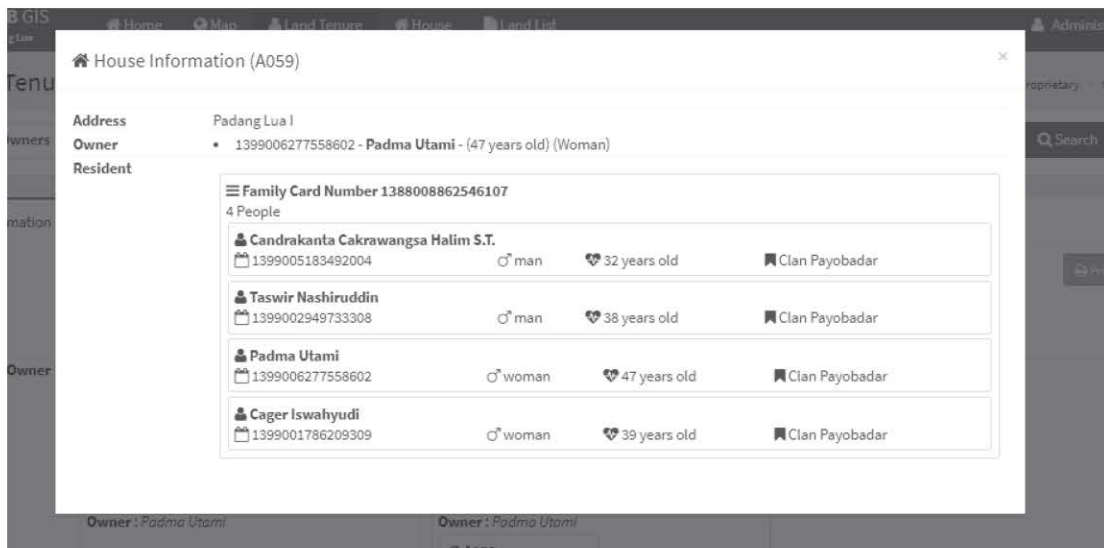
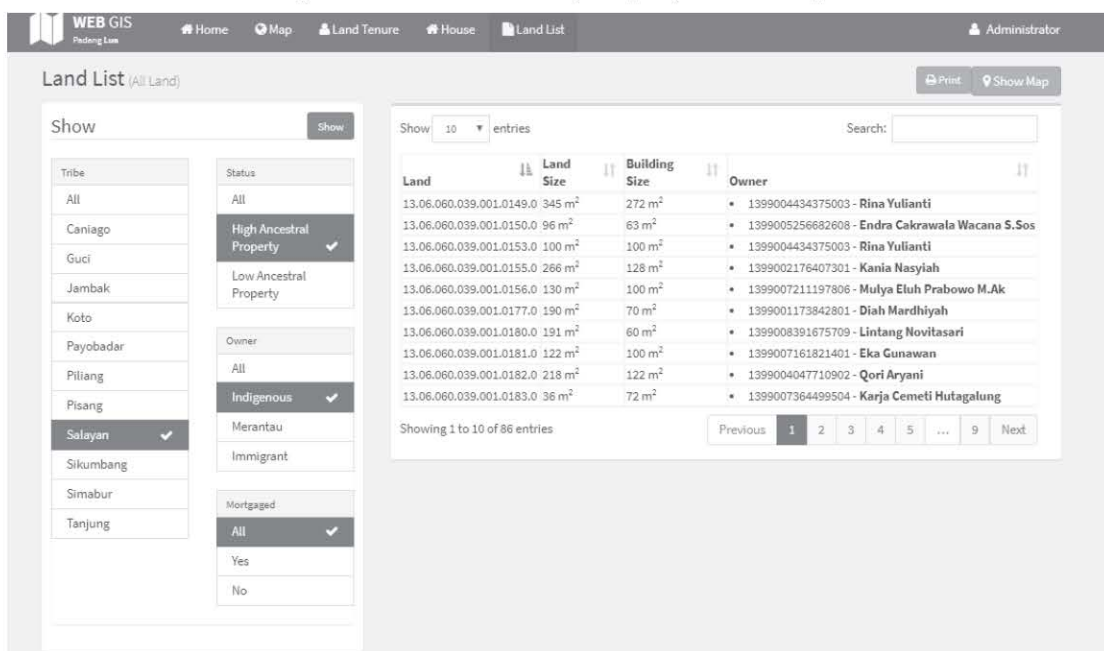Figure 12: Web GIS house (occupant) module output

Figure 13: Land List based on tribe, land status, resident status, and mortgaged land

Figures 8, 9, 10, 11, 12, 13, and 14 show the database developed based on the Minangkabau local custom has been able to provide relevant information for users to eliminate social conflict related to customary land and house sales. Users can know ownership of a parcel of land and can also know the owner of the house. The database is developed to facilitate separate ownership between customary land and house. A house built on customary land belongs to a particular family/tribe, but other people (the natives or other individuals who belong to the same tribe as the landowner) can own the house. In this case, the landowner is *mamak*

kepala waris or *penghulu,* and the house owner is a member of family/tribe. It is in line with the rule that customary land owned by the particular family/tribe is inherited or used by members of the family/tribe together for either residential or farming. Figures 9, 11, and 14 also mention that the developed web GIS application is able to provide map-based information to decrease social conflict due to customary land and house sales. Using web GIS technology, a prospective buyer or other users, for instance, Padang Lua natives who live in other places in Indonesia or other foreign countries can access the application through the Internet.
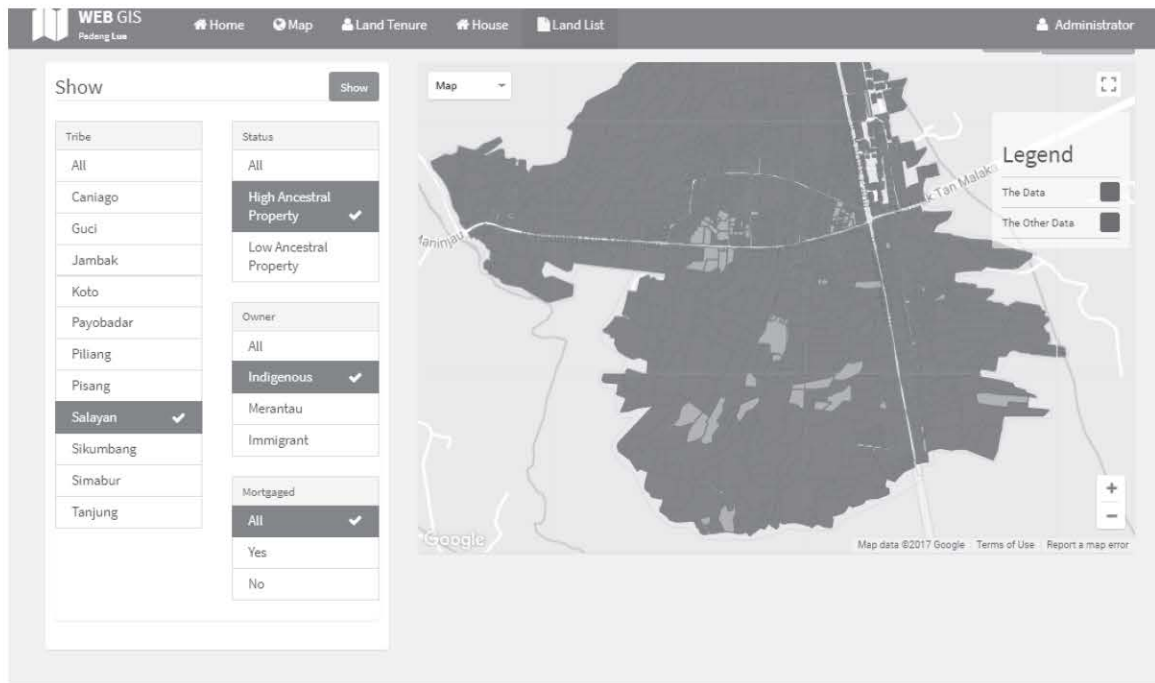
Figure 14: Land List (location) based on tribe, land status, resident status, and mortgaged land

The web GIS application is able to display the map resulting from a spatial operation based on user's need, such as land plots owned by an individual. The understanding of prospective buyers can be better with maps. The map allows prospective buyers to look up information about 1) location of the land plot he or she wishes to buy and other plots around it, 2) houses built on the land plot, and 3) location of the certain house. Conventional text system cannot convey that information.

This research found the importance of land status information, whether the customary property is owned or not. This aspect is very important for land purchasing process in Minangkabau. This activity was conducted to reduce future conflicts. One of the contentious issues is how to clarify land ownership when the owner has been migrating for ages without leaving any news. If the family members have used the land for agricultural activities, then it is not clear who the legitimate landowner is. If there are a large number of descendants, who will represent as the owner of the customary land? In next system development, a system that is able to correlate Minangkabau wandering culture (*rantau*) to the land and house ownership change can also be monitored by descendants in *rantau* area (current residence outside native land). This is believed to be one solution to eliminate potential conflicts over land and house ownership in Minangkabau.

6. Conclusion

Web GIS database and modules were developed in accordance with Minangkabau local custom has succeeded in solving issues related to land, house, and occupants. The Minangkabau custom rules for the ownership of land became the basis for the development of business processes applied to the database. The database supports the separation of customary land ownership, house as well as regulations related to other landowners in Minangkabau. Using the Web GIS modules, a prospective land buyer could find information on land ownership status in accordance with Minangkabau local custom, as well as land locations for sale. Information from Web GIS output could be utilized by a prospective buyer as a geographic reference or supporting deciding factor in purchasing land. Village head/officer could monitor land, house, and its occupants. Web GIS had reduced social conflict in Padang Lua. Future research would further develop Web GIS capability, which aiding Web GIS in monitoring land ownership change, tax payment, and villagers change by visualizing data into the map to house level. It would also serve as study material for Minangkabau children, whether in *rantau* (living in another city) or villages to understand their lands.

Acknowledgement

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