Implementation of 4D Cadastre Concept for Land Dispute Potential and Solution of Post Natural Disaster in Palu, Indonesia

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Key words: 4D Cadastre System, Natural Disaster, Land Dispute, Indonesia, Cesiumjs

SUMMARY

Indonesia is a law county and pancasila regulations based in implementation of agrarian reform and presenting a 2D cadastral administration system for land registration, providing clarity of land rights, land valuation, and land use. However, the 2D cadastral system in Indonesia is vulnerable to overlapping because some agencies use different projection systems to present maps of land ownership, taxation, forestry, and so on. As sustainable development advances, applying 3D cadastre is the best solution in determining overlapping mapping and can identify 3R (right, restriction, responsibility) and represent 3D model information. However in implementation, it needs to be integrated with time as an additional dimension in 4D cadastre mapping (3D + time) because land disputes and natural disasters can occur at any time and brings many disadvantages to the land system, for example in December 26, 2004, earthquakes and tsunami devastating Banda-Aceh, North Sumatra which causes land registration documents and land ownership information or land parcel are gone. Recently in September 28, 2018, earthquakes around 7,5 M_L and tsunami with height approximately 3 meters above MSL destroyed Palu-Donggala, Sulawesi. This natural disaster causes more than ten thousand of peoples die. The goal of this research is to elaborate information system of 4D Cadastre to facilitate and explain the digital results of legal property law who owns land certificate or in specific of an owner of apartment. Using 3D model data from Orthophoto and Cesiumjs are expected to show 3D including position and height (x, y, z) and time (t) in the application in this case can be in website. The land data will be recorded in a system, thus can be used as an archive of the history of ownership and can be used to simulate the lost data or add spatial planning in the future.

SUMMARY (optional summary in one other language in addition to English, e.g. your own language)

Indonesia adalah negara hukum yang berdasarkan peraturan undang-undang dan Pancasila dalam pelaksanaan reforma agraria serta menerapkan sistem administrasi kadaster 2D untuk pendaftaran tanah, memberikan kejelasan hak atas tanah, penilaian tanah, serta peralihan hak penggunaan lahan. Namun, sistem kadaster 2D di Indonesia sangat rentan mengalami tumpang tindih (*overlap*) karena beberapa instansi menggunakan sistem proyeksi yang berbeda untuk mempresentasikan peta kepemilikan tanah, pajak, kehutanan, dan lain-lain. Seiring dengan kemajuan pembangunan berkelanjutan, menerapkan kadaster 3D adalah solusi terbaik dalam menentukan pemetaan yang overlapping dan dapat mengindentifikasi 3R (*right, restriction, responsibility*) serta mepresentasikan informasi 3D model. Tetapi dalam pelaksanaannya, perlu integrasikan dengan waktu sebagai dimensi tambahan dalam pemetaan kadaster 4D (3D + waktu) karena masalah sengketa tanah dan bencana alam dapat terjadi kapan saja dan sangat merugikan sistem pertanahan seperti contoh bencana gempa bumi dan Tsunami pada tanggal 26 Desember 2004 yang mengakibatkan hilangnya persil atau batas hak suatu kepemilikan di Banda Aceh. Pada tanggal 28 september 2018, di Indonesia khususnya di Palu-Donggala, Sulawesi terjadinya bencana alam gempa bumi dengan kekuatan 7,5 SR dan Tsunami dengan ketinggian 3 meter dari MSL sehingga mengakibatkan puluhan ribu warga Indonesia meninggal dunia. Dalam tujuan penelitian ini, Indoneisa dapat menerapkan konsep Sistem Informasi Kadaster Empat-dimensi (4D) untuk memudahkan dan menjelaskan hasil digital atas kepastian hukum pada hak seseorang yang memiliki asset tanah atau ruang dalam bentuk sertifikat tanah atau apartment. Menggunakan data 3D model dari Orthophoto dan Cesiumjs untuk menampilkan 3D meliputi posisi dan ketinggian (x,y,z) dan waktu (t) pada aplikasi atau website. Data yang hilang akan terekam dalam system tersebut sehingga dapat menyimpan sebuah sejarah kepemilikan dan dapat menyimulasikan data yang hilang atau menambahkan perencanaan suatu tata ruang pada masa yang akan datang.

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1. INTRODUCTION

Community needs for land use are increasingly extensive and dynamic. Moreover, spatial planning must be consider some features such as the number of parcels available (2D), vertical space (3D) and time-related data ownership (3D + time, or 4D) is needed. According to some references (see, Stoter, 2004; van der Molen, 2003; van Oosterom et al., 2006), cadastres are the representation of land divisions which is provided in 2D. However 2D cadastres are not good enough for elaborating, analyzing and modeling commodity information with the complex of interests on land (Bennett et al., 2008; Kalantari et al., 2008). In another some references (Guo et al., 2012; Hespanha et al., 2006; Ho and Rajabifard, 2012; Stoter, 2004; van Oosterom et al., 2002), they discussed some options for transitioning 2D to 2D + time or 3D registration. But the increasing of land requirements and land values cause an increase in the need for 4D information (including 3D) in cadastral registration (van Oosterom et al., 2006). In this case, 4D cadastre is needed which is a measurement, mapping, recording and merging of spatial data related to position (x,y), height (z) and time. 4D cadastre can be used when historical records are needed to prove the certainty of land rights in cases of land disputes in court and the development of land use in certain areas to support future land policies (Doner et al., 2011).

Currently, Indonesia is implementing a 2D cadastral administration system (Hendriatiningsih et al., 2007). Here, 2D cadastral systems are very vulnerable to overlapping because some agencies use different projection systems (UTM and TM3) to present tax and land ownership maps. 2D cadastral systems also cannot provide additional information regarding the status of land and space ownership in apartments or flats (Stoter and Ploeger, 2003), so this often results in cases of land disputes (Stoter and Zevenbergen, 2001). Land disputes, according to data from the Ministry of Agrarian Affairs and Spatial Planning, revealed that out of 2,368 land disputes, only 480 cases were resolved in 2018 (CNN, 2018). On the other hand, the potential for land disputes can also be caused by the loss of parcel boundaries due to natural disasters. Natural disasters are very detrimental and can occur at any time, for example the earthquake and tsunami disaster on December 26, 2004 which resulted in the loss of parcels or ownership rights in Banda Aceh (Abidin et al., 2005). On September 28, 2018 (in Figure 1), in Palu and Donggala, Central Sulawesi, a devastating earthquake of 7.5 magnitude and a tsunami with a height of 3 meters from the Mean Sea Level (MSL) resulted in the loss of tens of thousands of parcels and people died, resulting in potential disputes soil. Therefore, to face and anticipate

these problems, 4D monitoring, management and visualization are needed to alleviate the burden of state losses (Du et al., 2006).

Figure 1. Petopo, Palu situation after natural disaster

The development of the 4D cadastre is important for various aspects of infrastructure development and land registration. The advantages of 4D cadastral to know ownership history (ownership history) and become an asset for legal certainty (van Oosterom et al, 2006). The purpose of this study, Indonesia can apply the concept of a four-dimensional cadastral information system (4D) to facilitate and explain the digital results of legal certainty in the form of electronic land certificates or simulated 3D apartments and in court session to prove land rights in land dispute cases. In its implementation, combining the 4D cadastral concept with a website-based Geographic Information System (GIS) with the CityGML model can present a 3D + time visualization (Chaturvedi, 2014). The land data will be recorded in a system, thus can be used as an archive of the history of ownership and can be used to simulate the lost data or add spatial planning in the future.

2. METHOD

To realize the 4D Cadaster Information System, several stages are needed to obtain information related to land size, ownership data, land history related to ownership history, supporting maps to build 3D models such as aerial or lidar photographs, identification of lost land and identification of potential land disputes. The following methodology flowchart can be seen in Figure 2.

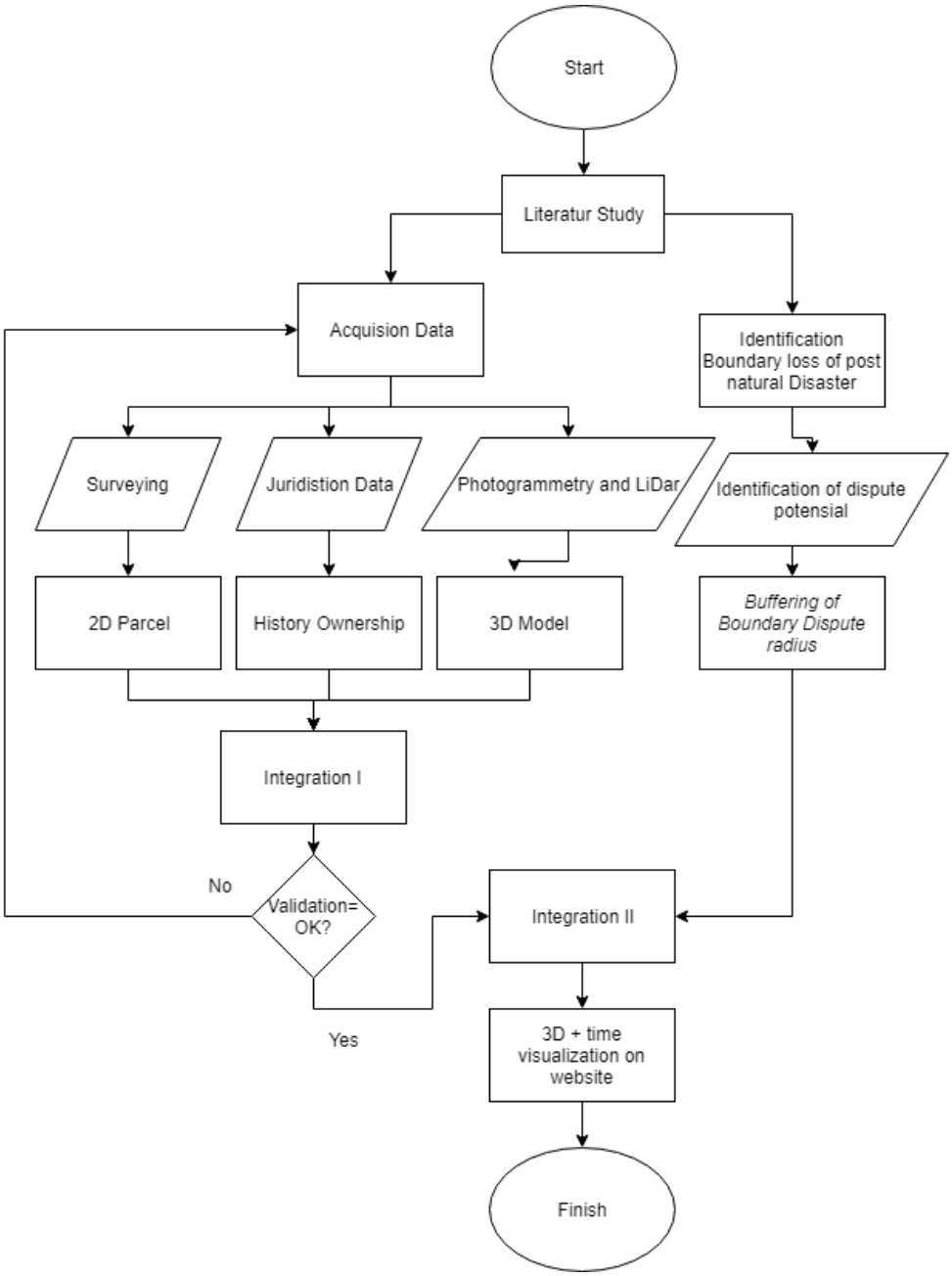

Figure 2. Flowchart of this research.

The research begins with collecting literature or literature studies related to 4D, 3D, CityGML or BIM cadastral systems, as well as potential land disputes that occur after natural disasters due to the loss of boundaries that will be used for the needs of library studies. The source of the library can be in the form of book rules, journals, laws, official websites, research report articles, and official documents of the relevant agencies. In data retrieval, it will utilize adjudication methods such as land registration measurements, juridical data, and 3D modeling using

photogrammetry or Lidar to obtain Point Cloud data as well as additional supporting information such as taxes, heirs, and others so that it can be processed in the CityGML modeling system or BIM and Postgres. The results of the data related to the 3D model can be visualized with CesiumJs or electronjs (opensource software) as well as the results of a literature study on the concept of 4D cadastral information systems as assets in investigation, the adjudicate, and court judgment, monitoring and others.

3. DISCUSSION AND RESULT

In general, land conflict causes many negative effects for human life. This can impact the social development with followed by the economic and ecological system. Specially, at developing and transition country, since this conflict can be happened any time due to the weaknes of land market institutions. Moreover it will make more difficulty for poor people due to their lack access to their land (Wehrmann, 2008). Therefore, land administration and its management are important in this case in order to minimize the land conflict. Indeed the role of the government to provide the good facilities for public land adinistration is also become important part.

In this research case, where the location is in Petopo village, South Palu sub-district, Palu city, Central Sulawesi Province. Seen in the Google Earth satellite imagery in Figure 3, in a vulnerable period of time from August 10, 2018 (left-side) there are no occur when natural disaster with namely earthquake, tsunami, and liquefaction. On October 2, 2018 (right-side) there was occur a natural disaster thus lots of people died and lost their boundary of own land right.

Figure 3. (a) imagery in the left side at August 10, 2018,
(b) imagery in the right side at 2 October 2018

The research continued to the location by flying DJI Phantom Pro 4 drone to obtain imagery photo data and can be used as orthophoto maps to seen clearer than satellite imagery with a resolution of 3 cm, can be seen in Figure 4.

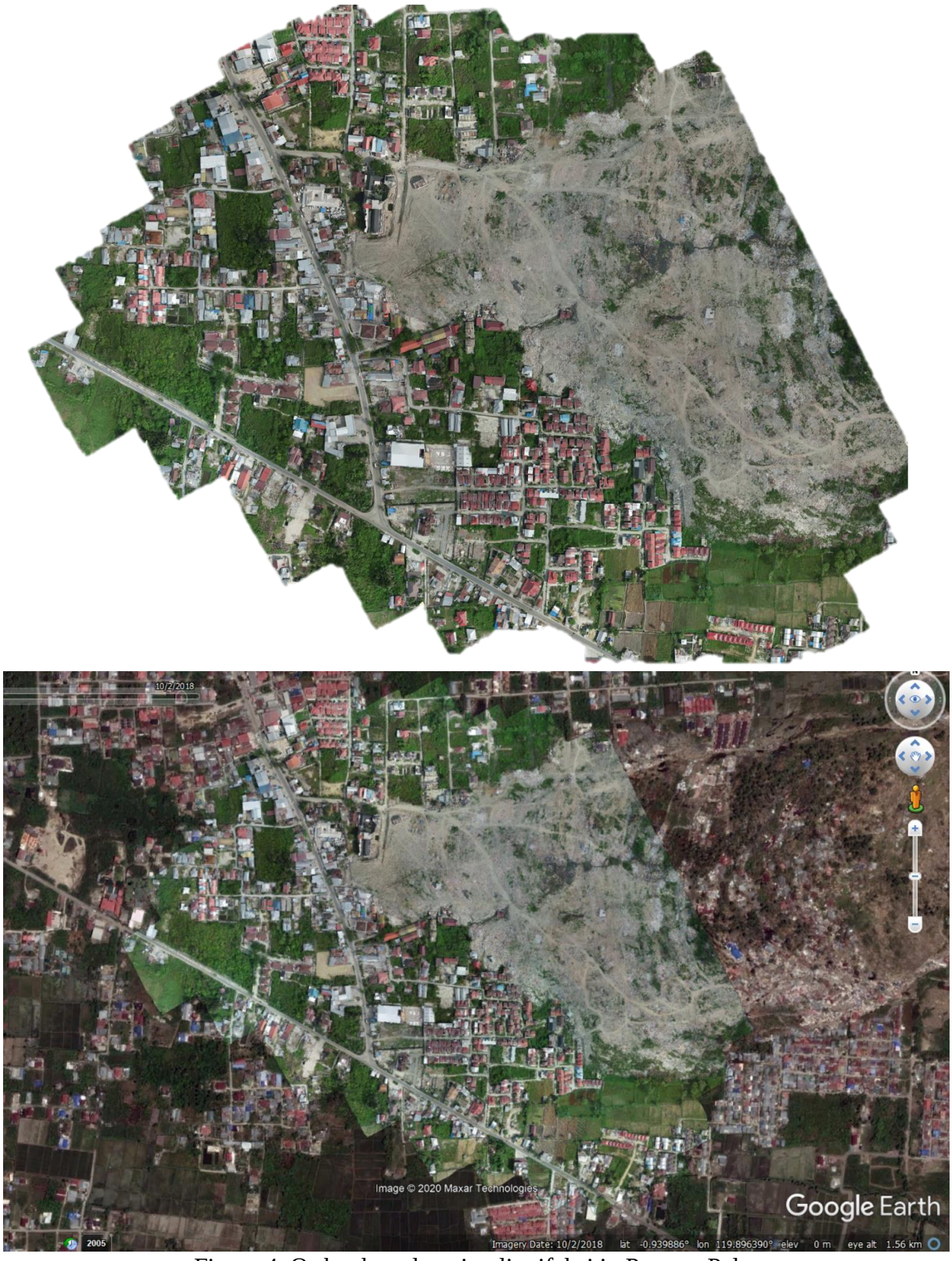

Figure 4. Orthophoto location liquifaksi in Petopo, Palu.

In Indonesia, ownership rights are in the form of land certificates through a complete systematic land registration program (PTSL) for economic equality in Indonesia as outlined in agrarian reform policies. Legitimate and legal proofs in land ownership are legal in the adjudication of the ministry of Agrarian Affairs and Spatial Planning (BPN) thus this is legal in Indonesian law on land ownership. On the website (https://www.atrbpn.go.id/Peta-Bidang-Tanah) there are several parcels in locations affected by natural disasters in the Petopo village.

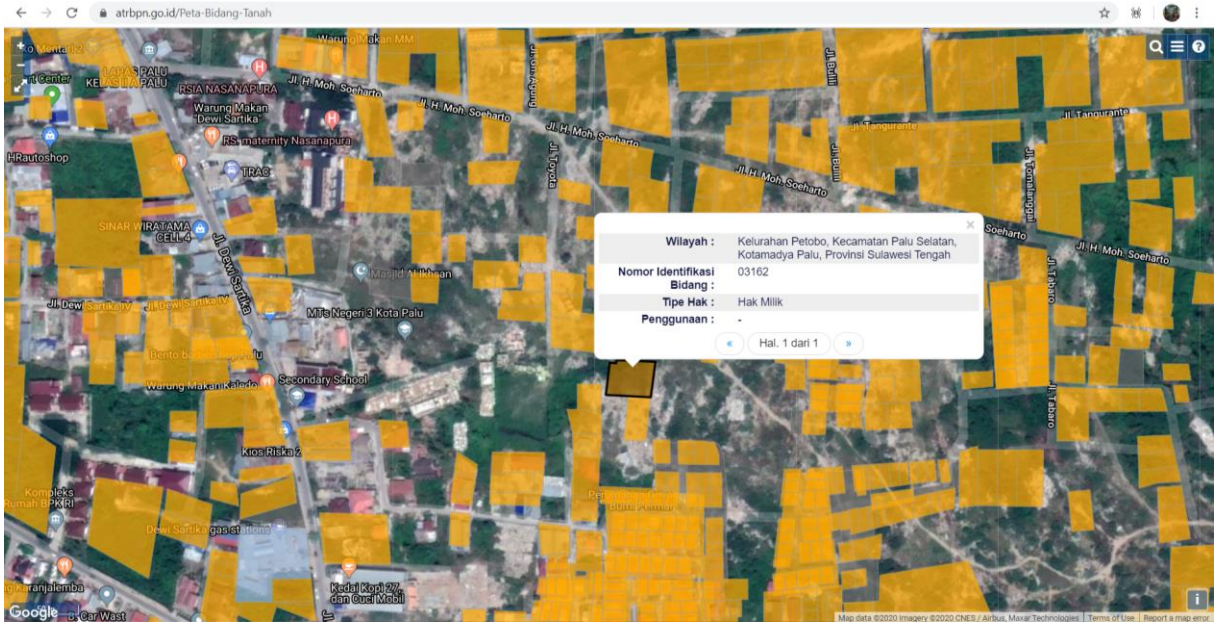

Figure 5. Ownership data from the Ministry of Agrarian Affairs and Spatial Planning (BPN)

Incomplete parcels in one area will occur potential land disputes in the future and that is leading to a lot of problems which we need to address. One of the problem is the reconstruction of lost boundaries and unilateral recognition by a number of persons or unauthorized persons in ownership.

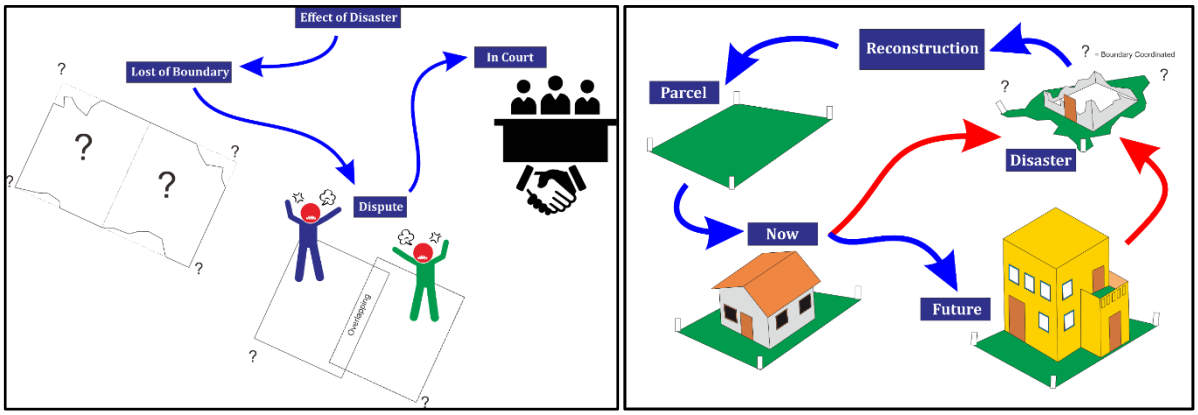

Figure 6. Effect of disaster and loss of boundary and Reconstruction for Future

In Figure 6 (left-side) the effects of disaster caused of loss of boundaries thus agreement is needed in the determination of land boundaries and if there is no agreement it will end in court session. That reconstruction of land boundaries (right-side), requires accurate data and detailed of land administration system and there is a 3d model thus it can quickly determine decisions.

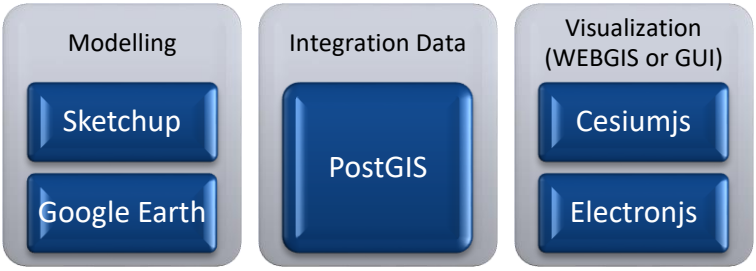

Figure 7. Method of 3D Modelling Visualization

In this research, using tools (Sketchup and Google Earth) to create 3D models and integrate with postgis for databases thus can be visualized into website or application in the form of GUIs can be een in Figure 7.

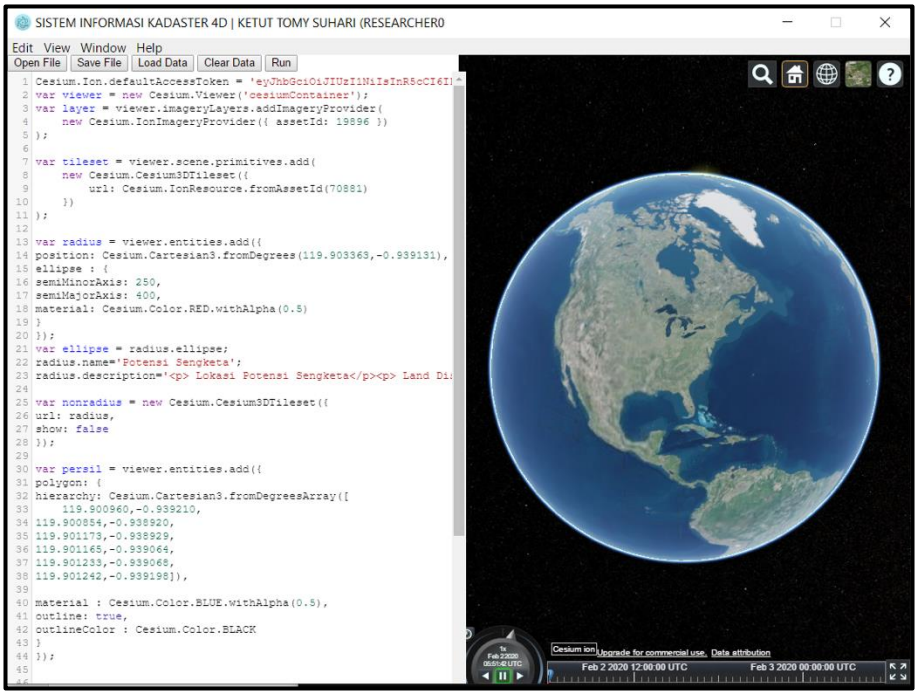

Figure 8. Electronjs based of GUI for SIK4D Visualization

Sistem Informasi Kadaster 4D (SIK4D) or 4D Cadastre Information System was introduced in Figure 8. This software is electronjs (opensource) with javascript and html based. It useful for visualization the 3d model and set the time. With the cesiumjs based in electronjs GUI, it can insert the data 3d model in orthophoto file (see in Figure 9) and 3D Model from skecthup to

CityGML, Level of Detail (LOD) 1 (shown in Figure 10) which is blue colors are sample of ownership rights.

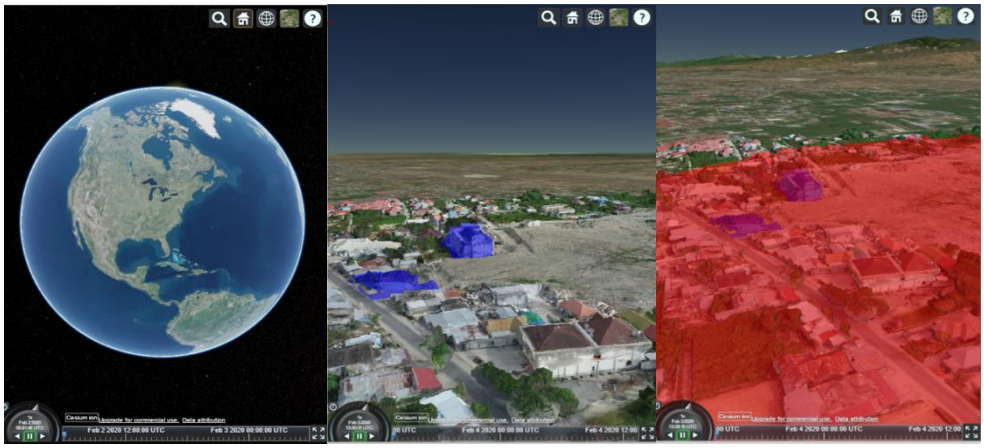

Figure 9. Modelling using photogrammetry

This research is integration SIK4D with potensial land dispute with radius 200 meter, due to the lack of available parcels and ownership rights that it can be assumed that a potential dispute will occur in the reconstruction or consolidation on that radius. This software can adjust the time, that it is useful and needed in analysis, monitoring and allows in real time if it is integrated with IOT. This will be the basis in the investigation, the adjudicate, and court judgment for future disputes.

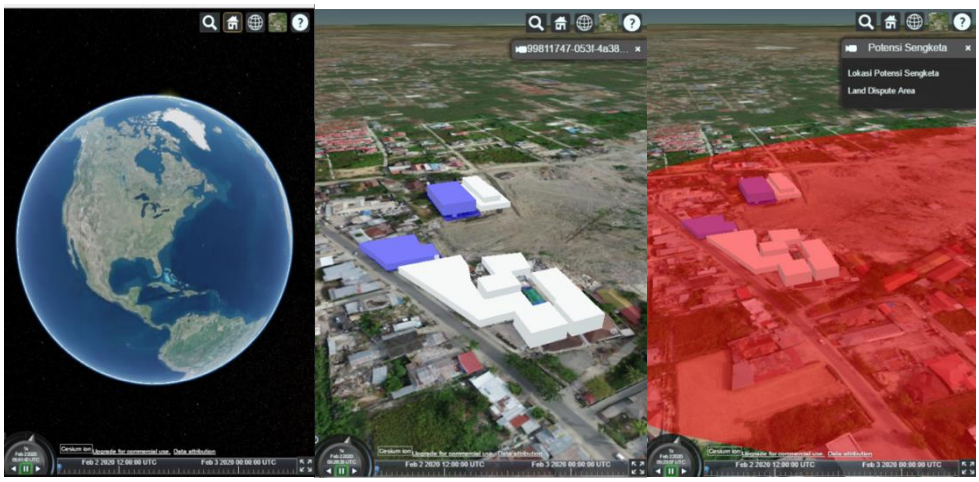

Figure 10. 3D Model for LOD 1

4. CONCLUSION

The goal of this research, is to elaborate information system 4D Cadastre to facilitate and explan the digital results of legal property law who owns land certificate or in specific of an owner of apartment. Using 3D model data from Orthophoto, LOD 1, Cesiumjs and electronjs are expeted to show 3D including position and height (x,y,z) and time (t) in the application or website. The spatial data will be recorded in a system, thus can be used as an archive of the history of ownership and can be used to simulate the lost data or add spatial planning in the future. The software can adjust the time, that it is useful and needed in analysis, monitoring and allows in real time if it is integrated with IOT.

By using the 4D Cadastre Information System, it will minimizing land disputes which can occur at a late time. This will be the basis in the investigation, the adjudicate, and court judgment for future disputes. For future work, using the LOD 2, 3 and 4 in CityGML can be well integrated as long as it is used and modelled into Cesiumjs for visualization purposed.

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6. BIOGRAPHICAL NOTES

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