Geodiversity of the Togean Islands National Park, Central Sulawesi Province for Geopark Assessment

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Abstract. The Togean Islands National Park is located at the Gulf of Tomini, Central Sulawesi Province, Indonesia. The islands officially become National Park in 2007, initiated by the government of the Tojo Una-Una district in 2004. There is a variety of geodiversity within the Togean Islands National Park, such as active volcano, ophiolitic pillow lava, beautiful beaches and islands formed by lithology of volcanic deposits, igneous intrusions and quaternary limestone formation. Four geodiversity areas are provided within the national park, according to lithological and geomorphological aspects. Those are the Una-Una Island active volcano, karst topography of limestone around the Batudaka Island, the lava dome at the Togean Island and the ophiolite complex of Walea Islands. The Una-Una volcano island is unique based on the location and anomaly in magma affinities. The Soliter volcano separated from the volcanic belt along the North Sulawesi Arm and has the adakite signature compared to tholeiitic - calc-alkaline as dominant affinities from the North Sulawesi island arc province. The Batudaka Island - karst topography offers sailing and cruiser to the beautiful shape and scenery of karst topography of limestone formation, cave, sandy beaches and blue ocean. The lava dome of the Togean Island: provides a geomorphological landscape that represents the dome of trachytic igneous rock above sea level. The Walea ophiolite: of a geoheritage showing rock formation, consists of ophiolitic pillow lava and the tectonic fossil of subduction between tectonic plates around Sulawesi Islands. Overall, the Togean Islands National Park proposes many adventure sites for diving, snorkelling, surfing, fishing, sea birds and dolphin watching and also conservation of reef, fish and geoheritage sites. Several facilities are already available inside of the National Park, such as resorts and cottages for accommodation, sailing and diving rental for leisure activities.

1. Introduction
The terms of geodiversity, geoconservation, geoheritage and geopark are still not fully recognized and understood by society. Firstly, geodiversity is the natural range (diversity) of geological (rocks, minerals, fossils), geomorphological (landforms, physical processes) and soil features [1]. Geodiversity as the basis for the selection of geoconservation sites should be chosen to represent the geodiversity of a country, province or region [2].
The next level is geoheritage which is a high value geodiversity that needs to be protected to the next generation and contains many aspects for scientific, education, aesthetics, culture, tourism, and environment. Geoconservation derives from geoheritage to protect and conserve geological component of high value or uniqueness [3].

At last, geopark is a geological heritage that has scientific importance value of geological, geomorphological conditions and has direct relevance to people’s cultures. United Nations Educational, Scientific and Culture Organization (UNESCO) defined UNESCO Global Geopark as single, unified geographical areas where sites and landscapes of international geological significance are managed with a holistic concept of protection, education and sustainable development [4]. UNESCO Global Geoparks is established through a bottom-up process involving all relevant local and regional stakeholders and authorities in the area (e.g. land owners, community groups, tourism providers, indigenous people, and local organizations).

Togean Islands has the opportunity and advantages to become global geopark by UNESCO definition. The islands has already been a member of National Park of Indonesia since 2007, initiated by the government of Tojo Una-Una since 2004, located at the Gulf of Tomini, Central Sulawesi Province, Indonesia, situated between the North Arm and East Arm of Sulawesi (Figure 1).

![Figure 1. Togean Islands National Park, Central Sulawesi Province.](image)

Geologically, Togean Islands lies in a complex tectonic regime area; belongs to the Sulawesi or Molucca Suture where the three plates (Eurasian, Indian-Australian and Pacific-Philippine) are converging (Figure 2). According to the complex geological setting in these islands, many geodiversity could be identified by lithology and geomorphological aspect.
Figure 2. Principal geographical features of South East Asia. The lighter shaded areas are the zones of collision between the Eurasian, Indian–Australian, and Pacific–Philippine Sea plates [5].

As a national park, Togean Islands National Park is protected by the environmental and conservation laws. Although it has been protected, geodiversity in this island has not been exploration and appointed to be a geoheritage or a geoconservation site. Determination of geoheritage and geoconservation site is important for geopark assessment which is required by UNESCO Global Geopark.

2. Data and Method
The inventory of geodiversity sites is the first and crucial step in any geoconservation strategy. A geoconservation strategy is based on several steps: inventory, quantitative assessment, conservation, interpretation, promotion, and finally monitoring sites [6]. The method for inventory of geodiversity in this national park was followed by the instruction paper in [7] for geodiversity inventory and geoheritage identification. The procedures for inventory of geodiversity consist of field survey,classification, ranking, assessment, and clustering.

This paper only discusses inventory of geodiversity at the Togean Islands National Park, focus on field surveys and making classification of the geological diversity base on geomorphological landscape, lithology and geological process. The list of geodiversity will be proposed to the geoheritage - geoconservation area even though the area is already inside of the national park.

Four geodiversity areas are provided within the Togean Islands National Park according to lithological and geomorphological aspects. Those are the Una-Una Island Soliter volcano, karst topography of limestone around the Batudaka Island, the lava dome at the Togean Island and ophiolite complex of the Walea Islands, as described in detail afterward. Literature data on biodiversity in the Togean Islands from [8] add value for further geopark assessment.

3. Result and Discussion

3.1. The Una-Una Soliter Volcano
This volcano is unique based on the location and anomaly in magma affinities. The Soliter volcano is separated from the volcanic belt along the North Sulawesi Arm and has the adakite signature compared to tholeiit - calc-alkaline as dominant affinities from the North Sulawesi island arc province [9]. This island is dominated by volcanic products such as lahar, pyroclastic deposit and lava (Figure 3). Beautiful landscape of the lake crater in the centre of island and diving spots around the island contributes to add values of geodiversity and biodiversity in this island (Figure 4 (A) and Figure 4(B) respectively).
Figure 3. Lithological and geomorphological observations on the Una-Una volcano island.

Biodiversity on the Una-Una Island and also other islands in the Togean Islands, according to [8] represents an incredibly diverse floral and faunal intersection of the South-East Asian and Australian biogeographical regions which has resulted in an astounding number of endemic species. The Togean macaque (*Macaca togeanus*), lizard (*Varanus salvator togeanus*), and tarsier (*Tarsius togeanus*) are terrestrial biodiversity which are only found in Togean Islands. Also the marine biodiversity includes the giant coconut crab, endangered migrant species such as the dugong, hawksbill and green sea turtles. The Conservation International Marine Rapid Assessment Program (MRAP) survey found relatively high numbers of marine species, six new fish species and fifteen reef corals found may prove to be found only in the Togean Islands [8].

Figure 4. (A) Lake Crater of Mount Colo, in the centre of the island. (B) Diving spot near the Una-Una Island.

3.2. The Batudaka Karst

Batudaka Island is dominantly formed by reef limestone (Figure 5), this island offers sailing and cruiser to the beautiful shape and scenery of karst topography of limestone formation (Figure 6 (A)), as well as the beautiful view of cave (Figure 6 (B)), sandy beaches and the blue ocean for diving spot. The Togean Islands containing all coral reef types (patch, fringing, barrier and atoll reefs) in close proximity. This phenomenon happens because of Togean Islands is located in the Coral Triangle, an area with extraordinary levels of marine biodiversity, roughly bounded by Indonesia to the west, the Philippines to the north and Papua New Guinea to the east [8].
3.3. The Toge Island

Going to the east from the Batudaka Island, there is the Toge Island which consists of volcanic rocks and Tertiary sediments (Figure 7 and Figure 8). The geomorphology landscape of volcanic rocks (Figure 9 (A)) representing the dome of trachytic igneous rock rises above sea level (Figure 9 (B)). Added value for the geopark assessment is the unique indigenous local. The Bajau are the indigenous tribe that built their house and live above the sea. Papan, Malange and Kabalutan Islands are home of Bajau families (Figure 10). Traditional attractions are also being encouraged in the community in Pulau Kabalutan village as part of the ecotourism project [8].
**Figure 7.** Lithological and geomorphological observations on the Togean island.

**Figure 8.** Lithological and geomorphological observations on the Talatakoh island.
3.4. The Walea Ophiolite

Walea Islands located in the eastern part of Togean Islands, consist of volcanics rocks (volcanic breccia, pillow lava and tuff), reef limestone and mineralized rocks (Figure 11). This area is proposed for a geoheritage preserving the rock formation by existence of ophiolitic pillow lava and deep sea sedimentary rocks which were emerged to the surface of the sea.

Pillow lava shows a concentric radial structure that is attributed to the extrusion of the lava under water or subaqueous environment (Figure 12 (A)). Next to the pillow lava, there are red claystone and greywacke sandstone outcrops that adding evidence that these deposits formed at the deep sea environment (Figure 12 (B)). This set of formation represents the tectonic fossil of subduction between tectonic plates near Togean Islands.

Figure 9. (A) Geomorphology of Togean lava domes. (B) Outcrop of lava dome at the Enam Island.

Figure 10. Bajau village at Kabalutan islands.
Figure 11. Lithological and geomorphological observations on the Talatakoh island.

Figure 12. (A) Outcrop of pillow lava with the radial structure. (B) Red claystone and greywacke sandstone outcrop at Walea Islands.

As summary, geodiversity, biodiversity and local community are preserved in the Togean Islands National Park. In 1998, Togeans Ecotourism Network (TEN) was established for local community networking, composed of community representatives who seek to establish guidelines for tourism, coordinate tourism services, and community groups of administrative villages. TEN was developed as a network to link ecotourism business players and also ecotourism products in certain community groups [8]. This community developed forest trails with a bird watching platform in Malenge village; developed buoys in the front of Kadoda village to protect the reef, the reef is a most visited reef by tourists until now.

Currently, Ampana Heritage Society and Himpunan Pramuwisata Indonesia (HPI), the tour guide association communities that are still actively promoting Togean Islands tourism. Several facilities are already available, such as resorts and cottage for accommodation; sailing, cruiser and diving rental for leisure activities. Overall, the Togean Islands National Park proposes many adventure sites for diving, snorkelling, surfing, fishing, sea birds and dolphin watching. These activities may support the sustaining local communities for the global geopark.
4. Conclusions
Togean Islands National Park has outstanding geodiversity, biodiversity and cultural diversity which will add values for the geopark assessment. The themes for each proposed geosite are (1) The Una-Una Soliter Volcano Island, (2) The Batudaka Karst, (3) The Togean Lava Dome, and (4) The Walea Ophiolite. Still need more effort from stake holder and authorized to manage, proposed and promote this area to become a geoheritage - geoconservation site first before it toward to Global Geopark.

5. References
[1] Gray M 2004 *Geodiversity: Valuing and Conserving Abiotic Nature* John Wiley & Sons Ltd., Chichester.
[2] Gray M 2008 Geodiversity: The origin and evolution of a paradigm *the History of Geoconservation. Geological Society* eds Burek C V & Prosser C D London Special Publication pp 31–36.
[3] Brocx M and Semeniuk V 2007 Geoheritage and Geoconservation – history, definition, scope and scale *J. of the Royal Society of Western Australia* 90: 53–87.
[4] UNESCO 2016 *UNESCO Global Geopark, Celebrating Earth Heritage, Sustaining local Communities* Paris, 20 p. Available online at: http://unesdoc.unesco.org/images/0024/002436/243650e.pdf.
[5] Hall R and Wilson M E J 2000 Neogene suture in eastern Indonesia *J. Asian Earth Sci.* 18 pp 781-808.
[6] Brilha J 2016 Inventory and Quantitative Assessment of Geosites and Geodiversity Sites: a Review the European Association for Conservation of the Geological Heritage *Geoheritage* 8 pp 119-134.
[7] Badan Geologi 2017 *Inventarisasi Keragaman Geologi dan Identifikasi Warisan Geologi*, Pusat Survei Geologi, Badan Geologi 16 p Bandung.
[8] Surjadi P and Supriatna J 1998 Bridging community needs and government planning in the Togean Islands Central Sulawesi Indonesia *Proceedings of the ICRI Conference* Australia.
[9] Sendjaja P 2013 *Petrology and geochemistry of volcanic rocks from the Togean Islands Gulf of Tomini Central Sulawesi Province: Implication for the tectonic setting of Sulawesi Island* Doctoral Dissertation Bandung Institute of Technology (ITB).