

**The Environmental, Economical, and Sociological Impacts of Tourism on the Water Supply
In Bali**

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

Depending on where one resides in the world, water can be a rare or common commodity. In most cases, water is readily accessible in developed countries and oftentimes inaccessible in some undeveloped and developing countries. This can present many challenges since most of the tasks that humanity performs requires water. The textile industry, agriculture industry, producing meat, and the creation of most products that we use every day requires water to produce an output.

In places that are developing, there can be some anomalies in water consumption and accessibility. One industry that has created an anomaly in water consumption is tourism. Generally, water use is higher in places with high amounts of tourism. The tourism industry has numerous interconnected parts contributing to its high water use. First, there is the influx of people that are populating these spaces (a resort for example) creating use per capita. This includes basic consumption, sanitation, and extracurriculars. Given a deep dive, the life cycle analysis of how much water a person consumes at a resort would give rise to thoughts on numerous questions ranging from the amount of water it takes to make food to the quantity of water used in the transportation of that food. In addition, considerations around the amount of water required in the operations of maintenance of a resort such as cleaning, grounds maintenance including plants and shrubs and recreation such as maintaining a swimming pool year round, should be taken into account.

Especially in undeveloped island areas, there is a disparity in the quality and quantity of the water that is received between the locals and tourists. Tourists go to resorts and receive as much water as needed with the best quality, while locals struggle to obtain water for basic

necessary agricultural based jobs. The tourism industry has created areas that can't be sustained due to the amount of resources that are being used in the present time. Tourism's impacts are felt in many prominent sectors in Bali. What impacts does tourism industry water use have on the environment, economy, and community in Bali?

Background and Significance

The country of Bali is an island province in the country of Indonesia. With only an area of 2,232 square miles, the population was projected to reach 4.4 million people by the end of 2023 (Statista Search Department, 2023). The province is considered to be a developing economy because their Gross National Income (GNI) and the Human Development Index (HDI) are both below the expected levels, but are steadily increasing. As seen in Figure 1, the sectors that provide the most to Bali's economy are tourism (indicated by the "Accommodation and food service activities" category in Figure 1) and Agriculture, forestry and fishing. These are also the sectors that use the most water in the province. The tourism industry uses 65% of the island's groundwater (Cole & Bowne, 2015). This goes to show how much more water tourism consumes than agriculture.

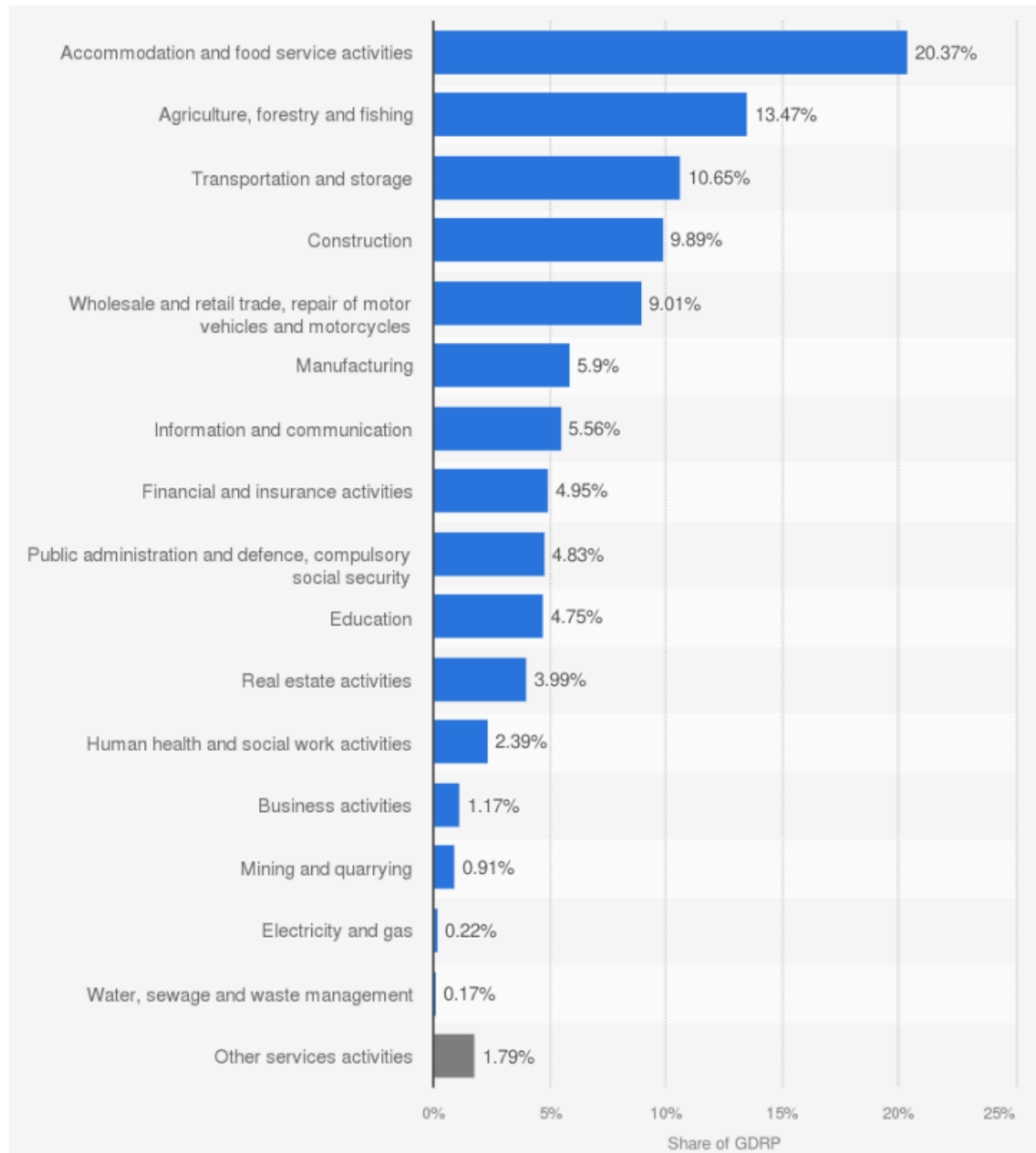


Figure 1. Gross domestic regional product (GDRP) distribution in Bali, Indonesia in the 3rd quarter 2023, by sector

Water is a very important part of the the religious component of Bali's Religion. It's common uses include consumption (*yeh*), healing (*amerta*), and holy water (*tirtha*). *Tirtha* is used for rituals that include the removal of pollution and purifications. Water is ingrained in their

natural systems where the hierarchy of high to low exists. To the Balinese people, water is not just a biophysical object that flows through nature, but a gift that has been given to the land. This gift has an intrinsic value and utilitarian merit of helping others and the environment it inhabits (Huang, 2020).

Bali's agricultural sector is known for its rich abundance of fruits and exotic coffee beans. To produce these natural wonders, certain water practices are used. One of the more important and sacred agricultural practices that the locals rely on is *subak*. *Subak* is an irrigation system of the Balinese people which involves customary laws and has distinctive socio-agricultural-religious characteristics. The Subak irrigation system has its roots in Bali's rich agricultural traditions and Hindu beliefs. It has evolved over time to become an integral part of the island's cultural fabric and it promotes harmonious relationships among community members. A *subak* is one of the few social structures in Bali. Previous versions of this have been on record for at least a millennium. The agricultural aspect of the *subak* is that each is essentially a complicated irrigation system that ensures the success of the cultivation of rice paddies. The *subaks* provide even water distribution over the area. *Subaks*, often compared to small governments, have a significant social influence on the community. It requires decision making, shared labor, conflict resolution, and community cohesion among members. The religious points of a *subak* are tied to Hinduism. Hinduism has influenced the way that the system is managed by integrating rituals, ceremonies, offerings, and prayers into their management of the water. These are often performed or spoken with the intention of seeking blessings, protection, and good fortune for the rice crops and the community that it surrounds (Huang, 2020).

Subaks are in danger because of the amount of water that is consumed by the tourism industry. The impacts of tourism have not been positive for any aspects of the *subak*. Tourism is quite literally draining the rivers dry. In fact, 260 of the 400 rivers in Bali have dried up because of tourism (Ritter, 2019). In some years during the dry season, there has not been enough water to go through the *subak*. This has led to negative impacts and hardships in maintaining the traditional social structures within *subaks* (Huang, 2020).

Agriculturally, the amount of land that is being used for tourism is growing exponentially, leading to impingement on land that has been used in the past for rice cultivation. There are also the effects of overdrawing water from designated wells. Due to the fact that it is cheaper to draw from unregulated wells instead of government owned pipes, the wells are being overused because of the demand. This overuse of groundwater has caused irreversible damage to the water table. Salt water can seep into the gaps that are caused by the overdrawing of the groundwater (Smith, 2018). This can cause contamination of plants with salt and create additional desalination costs on all industries that draw water from the ground. Tourism is also causing disruption of sacred practices that are seen in the religious and spiritual aspects of a *subak* such as disruption of land and harmony.

While tourism has admittedly had a significant impact on the economy in the past decade, it has had decidedly negative impacts on the natives who originally inhabited the island well before foreign tourists started. The quality and quantity of the water that is being rationed to the locals is impacting their way of life. Being the second most prominent industry in Bali, agriculture is much more than a means to make income (Statista Search Department, 2024). It's a

way of life that has been passed down through generations. If the water crisis continues on this path, there will be no water for the *subak* rice paddies or its constituents to drink. The impacts on the community, economy, and environment are clear from this one example.

Methodology

Tourism has many consequences for the province of Bali. There is the obvious intention of tourism, which is to boost the economy by creating jobs and sales markets for local goods and services. In addition, tourism revenue can be used to expand other important necessities in the country which includes infrastructure, energy, waste, and wastewater management. There are also the effects of tourism that are not directly considered such as tourism expansion affecting the environment, the people in local communities, and local community income. This dichotomy, rooted in the excess water use by tourism, is called latent and manifest dysfunction. This is the reaction of the subtle, unintended effects along with well meant intended effects. The latent and manifest dysfunction is the proper way to examine the disparities with water in Bali because of the assumed good intentions of tourism. However, it is important to look at all effects thoroughly and from all points of view to truly understand the topic.

To further delve into and understand this dichotomy, it needs to be understood that water is not just a physical entity but plays many major roles in society. As human development advances, water has become more embedded into our life, our government, and our politics. The social construction of technology theory (SCOT) stresses that technologies, in this case water, are developed in the sense of social and cultural contexts as well and it challenges our power relations in society. This view will be developed and discussed in the context of exploring the

usage of water in tourism and locally as well as how tourism's impact can be felt in the environment, the people, and the economy.

The research questions also involve examination of the power structures that water has created in Bali. For this paper, it will be discussed how water flows through different parts of Bali. The paper will also review where each industry (tourism and agriculture) primarily obtains water, which is one of the first steps to figuring out the differences in power structure that run through Bali. This can be further explained through the hydrosocial cycle. The hydrosocial cycle describes the dialectical cycle between water and society. Many entities use the idea of water management when distributing water. This idea isolates water from the reciprocal relationship with society. In reality, countries and territories should be practicing “water governance” which is the idea that involves the complex relationships between water and people. Water governance involves more stakeholders (civil society and water users) rather than just the distribution facilities and the governments.

Discussion, Results, and Literature Review

Local Life/Structure

The relationship between water and Bali tourism can involve multiple types of systems. Water is a very complex and mobile resource whose role in society has been downplayed as well as the important role that it serves around the world including socio-economic development and systems.

One such system is the hydrosocial cycle. It assumes that water and society remake each other through socio-natural processes. Water has determined how present day societies formed

and shaped boundaries. Because water was a great determining factor in the creation of societies, it has been something that humans have sought to control. The biophysical process of water is a cycle. However, unlike the simplistic definition of a cycle that is often taught in elementary schools, adding a few more variables shows how much exploitation and economic gain any municipality can try and gain. These incentives can create unequal distributions of water resources where some will financially benefit while others will bear the environmental and social cost of such water use. The phrase used by researcher Jamie Linton to illustrate this thought is “water flows uphill towards money” (Linton, 2013).

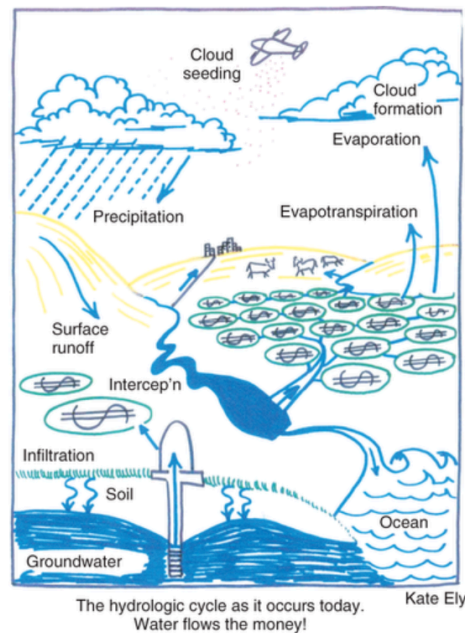


Figure 2. Image drawn by Kate Ely depicting the hydrologic cycle as it occurs in terms of the economy.

Looking at Figure 2 above, political and economic intervention has caused certain parts of the process to turn into opportunities for investment. However, investment and potential uses for the water are only the direct consequences of managing water in this chosen way (Linton, 2013). There are also the indirect consequences that societies face. In the specific case of Bali, it

has caused harm in numerous ways. The government in Bali determined it necessary to have 11 departments that manage and govern water through different entities. The amount of government stakeholders has created less cooperation between entities because of their varying rules, plans, and priorities (Cole, 2013).

Water and society will not always remake each other in the preeminent ways. The lack of coherency in the Bali government makes it difficult for water to be managed and distributed in ways that benefit all of its citizens. Unfortunately, the government is not enforcing the rules that they set up within the provinces. Therefore, stakeholders are not adhering to usage rules such as decreasing the amount of water consumption or the promotion of good water consumption techniques. These include limiting pool hours or limiting the amount of new towels being used by guests to use a washing machine less.

There is also a lack of understanding between the connection between water use, tourists, and employees of big spas and resort corporations. In a study done in 2010, out of 110 tourists, 50% had their towels changed everyday and less than 20% responded “yes” to the question “Have you noticed your accommodation making attempts to encourage you to save water?” Laundry and spa workers complained about an inadequate water supply, mentioning “catching drips all day, to get enough to wash the children”. Oddly enough, these workers saw no connection between water usage at work and the lack of water at home. At hotels and villas, water saving is linked to electricity saving due to the use of water pumps (Cole, 2013). While this association is true, there should be more emphasis on prioritizing the association between the commercial consumption of water leading to the lack of water for domestic use, due primarily to its finite trait.

Economy

Tourism has become ingrained in Bali's economy in the last decade. In the year 2023, as shown in Figure 3 , Accommodation and Food Service Activities contributed the most to the Gross Domestic Regional Product (GDRP) (Statista Search Department, 2024), leading Agriculture, forestry, and fishing by almost 5 trillion Indonesian rupiah (approximately 319.6 millions United States Dollars). Additionally, "Accommodation and food service activities" contributed to 20.37 percent of the total GDRP as shown in Figure 1 (Statista Search Department, 2024). With these statistics, there is no denying that tourism is a significant contributor to the GDRP of Bali. However, one must consider the overall consequences and impacts of this industry's growth rate.

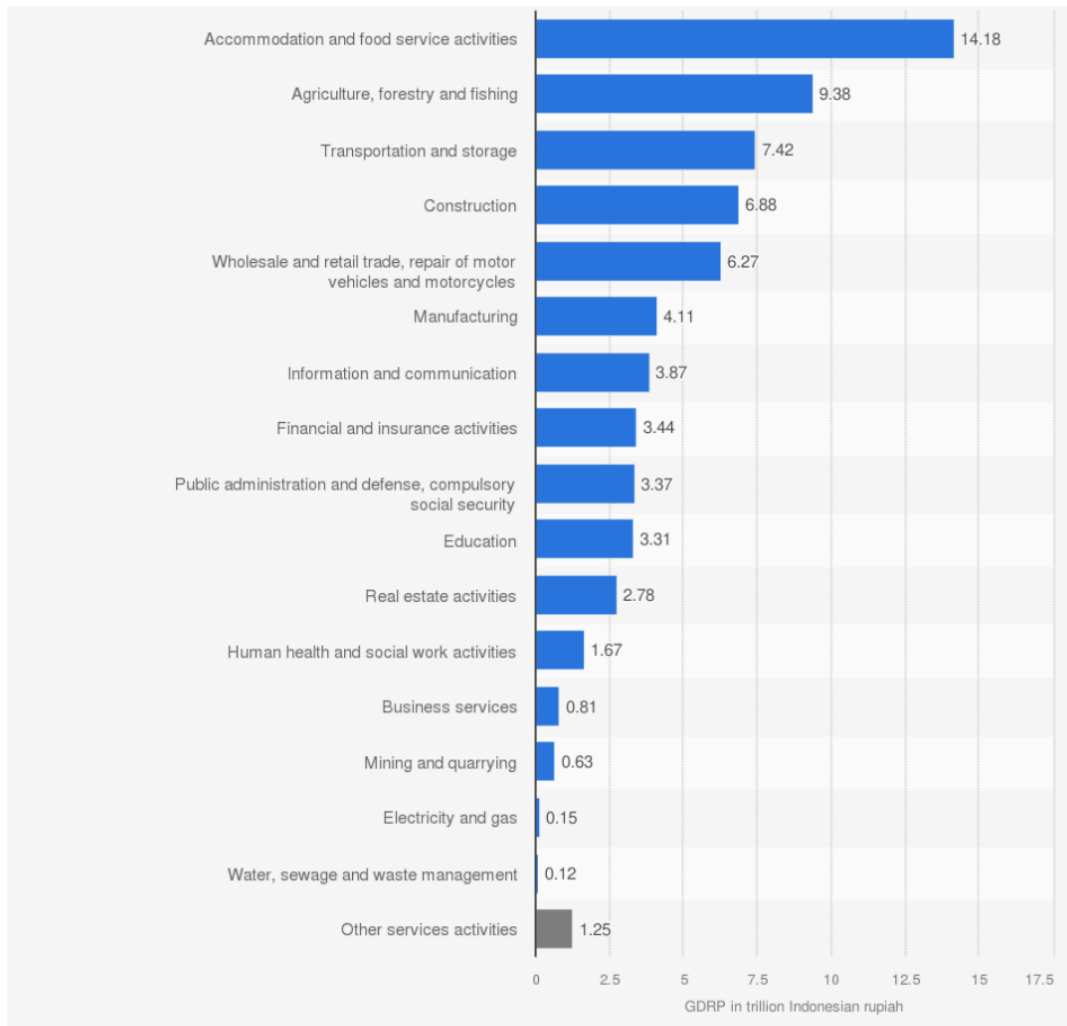


Figure 3. Gross domestic regional product (GDRP) in Bali, Indonesia in the 3rd quarter 2023, by sector (in trillion Indonesian rupiah)

Since there can be both intended and unintended consequences to every economic decision made, weighing the intended beneficial outcomes to the unintended negative effects would create better decision making by Balinese people.

Tourism brings income generation, employment opportunities, infrastructure development and its multiplying effects. However, this over reliance on tourism in Bali could lead to vulnerability during natural disasters, political instability, and global events, leading to a

sudden decline in tourists. This decline can result in a loss of revenue and economic hardships for local businesses or communities who rely on tourism as an income source. An example of this can be shown in the trend of the number of foreign tourist arrivals to Bali from the years 2008 to 2023. In Figure 3 it can be seen that from the year 2008 to the year 2019 there is a steady increase of the number of tourists. Then, in 2020 (the year that COVID-19 shutdown international travel) there was a very sudden decrease in tourists as compared to the year 2021 which saw zero tourist arrivals and 20,000 arrivals in 2022 (Nurhayati-Wolff, 2022).

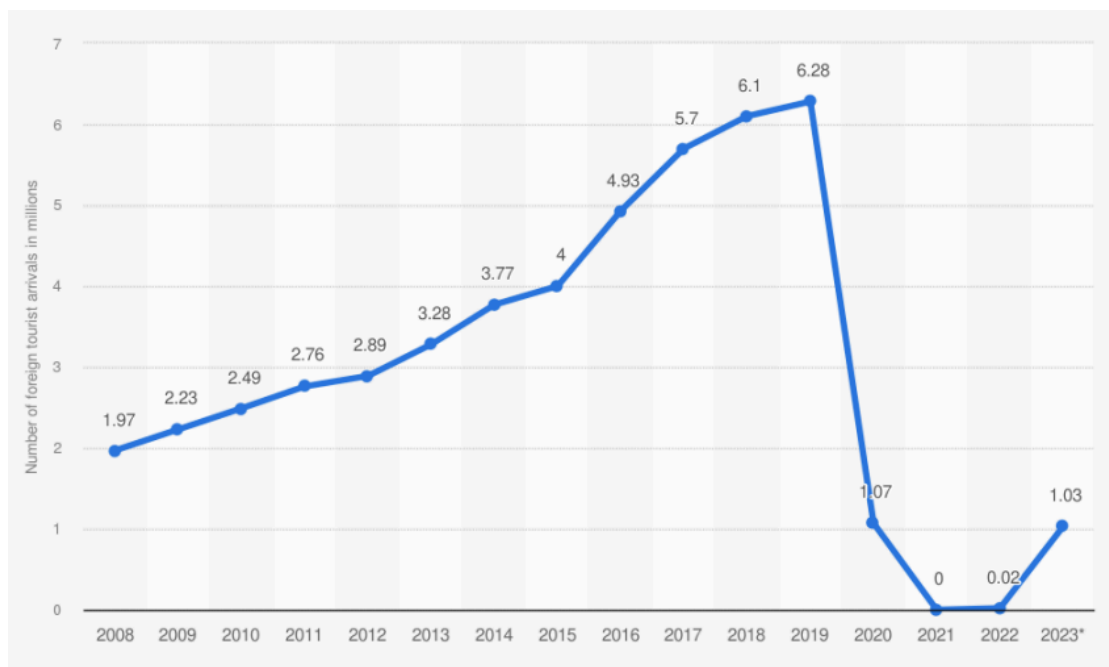


Figure 4. Number of foreign tourist arrivals to Bali, Indonesia from 2008 to 2023 (in millions)

Logically, more tourism would mean more jobs for the province which would in turn mean more income for the citizens. However, there is a discrepancy between urban and rural areas of Bali in terms of income distribution. Figure 5 shows the aggregate impacts of poverty incidence and income inequality on a national level. The results show that the growth of tourism

led to decreases in poverty and increases in income inequality between the years 2014 and 2022. The Figure 6 and 7 below shows the regional poverty incidence and income inequality rates between the years 2014 and 2022. These results suggest that foreign tourism is responsible for large decreases in poverty, but more income inequality than domestic tourism (Mahadevan et al., 2016).

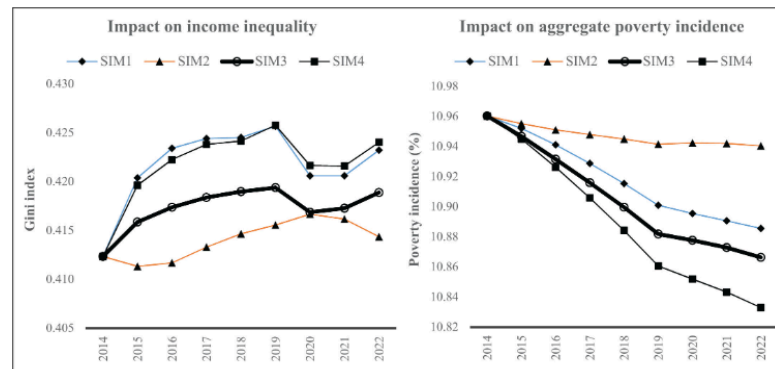
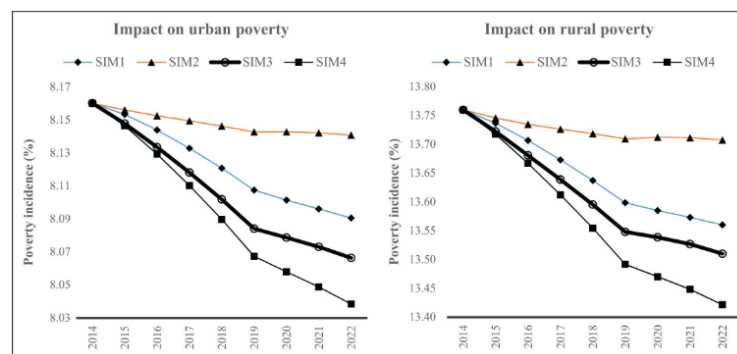
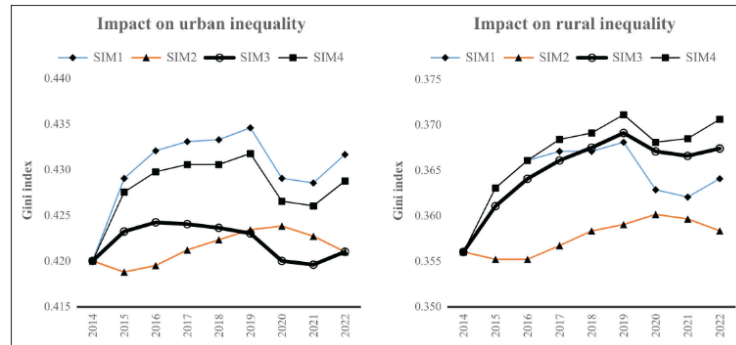


Figure 5. Aggregate poverty incidence and income inequality in the province of Bali between the years 2014 and 2022





Figures 6 and 7. Bali regional impact on poverty incidence (top) and regional impact on income inequality (bottom) between the years of 2014 and 2022

The main problem with tourism in Bali is that it is not sustainable. Many generations from now, people won't be enjoying the same Bali that some enjoy now due to the eroding effects of the industry on land usage, water quality and economical effects on rural communities. As defined by the UNEP in 2002, sustainable tourism development "meets the needs of present tourists and host regions while protecting and enhancing opportunities for the future." While most of those opportunities involve making sure that the natural environment and culture in Bali is able to be preserved, opportunities that ensure that economic benefits would be equitably distributed among stakeholders still exist. This does not exclude local businesses and small-scale enterprises, including the rural communities. Rural communities are a significant part of the culture of Bali and maintaining them ensures that Bali as a whole succeeds. Tourism, while a good portion of Bali's lure, is not the only thing that attracts tourists and makes Bali what it is today. Many people don't just travel for the resorts and amenities, but the picturesque nature and humanity of Bali.

Environment

As aforementioned, sustainable tourism focuses on preserving the environment for future generations. The excessive water use of the tourism industry is also creating changes in the environment that will be irreversible if there is no change from the current course of action. One of the impacts that tourism has had on the environment in Bali is Land Use and Land Cover Changes (LULC). These have to do with changes in the environment when humans transform the natural landscape. The land that is primarily used for land conversions to more urbanized areas are the rice paddy farms (*subaks*). When this land is converted, the once compact soil becomes susceptible to flooding and erosion. Less vegetation leads to more surface runoff. The LULC change between 2000 and 2016 can be seen in Figures 8 and 9 (Rimba et al., 2019).

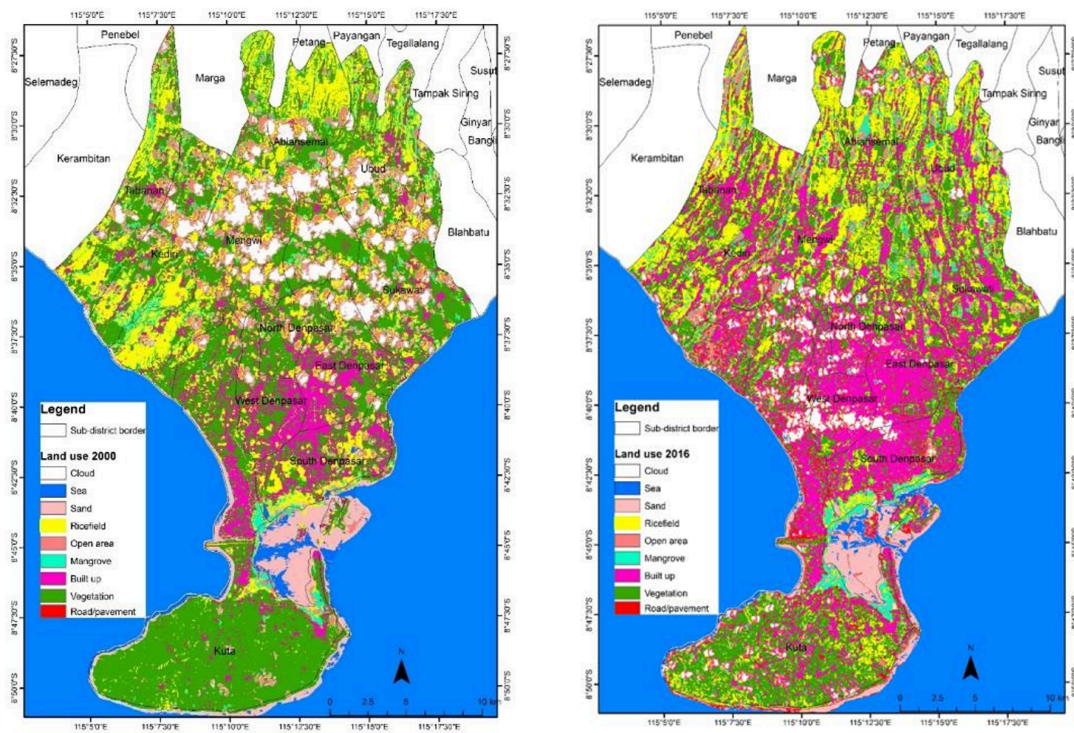


Figure 8 and 9. Land use changes between the years 2000 (left) and 2016 (right)

Another problem that comes with LULC is a side effect of the erosion is the pollution that ends up in waterways. A study done between the years 2007 and 2018 shows an analysis of

the 3 watersheds in the Bali Province. In these watersheds, the main types of land cover are rice fields, farms, forest, and built-up areas. The trend over time in all 3 watersheds is the “built-up area”: is the highest percentage of land. The study tested for eleven different water quality parameters (Ni, Pb, KMnO₄, Dissolved Oxygen (DO), Total Suspended Solids (TSS) Biochemical Oxygen Demand (BOD), NO₃, PO₄, E. coli, Cr, and Dissolved Fe). Within these parameters, certain values and ranges must be present in order to be classified as Drinking Water (DW), Raw Drinking Water (RD), Fishery breeding (FB), or Agriculture/Industry (AI). The correlation between the parameters of water quality and area is positive except for DO. DO is necessary for the survival of marine life. Low levels of DO is indicative of contamination. This indicates that water quality was deteriorating throughout the watersheds (Rimba et al., 2021) .

In addition to the quality of the water being deteriorated by urbanization, the water carrying capacity in Bali is also in a deficit and decreasing every year. The water demand that Bali has is exceeding the supply. In 2008, there was a study that found Bali having a water supply of 4.71 billion m³/year while 5.46 billion m³/year was the demand. This calculates to a deficit of minus .75 billion m³/year. Most of these deficit problems are solvable with better enforcement of the rules and regulations regarding water distribution (Sutawa, 2012).

Conclusion

There are many different ways that tourism has impacted the province of Bali both positively and negatively. This includes the use of land and water consumption. By developing land for tourism, there has been less land for one of Bali’s sacred agricultural practices of irrigation and for growing rice, a *subak*. The overconsumption of water in the tourism industry

has also led to a decrease in the amount and the quality of water that current *subaks* receive. Due to the decentralization of Bali's water management system, lack of reinforcement, and the public's lack of knowledge in the realm of water management, there is a lack of overall structure on how water is distributed in Bali. This has led to most of the rural population being at a disadvantage in regards to the quality and quantity of water that they receive.

The impacts of changing land cover in Bali has also negatively impacted the island. More urbanized areas have allowed for more surface runoff which contributes to flooding and erosion, bringing unwanted chemicals and making water quality downstream a growing hazard. Additionally, due to the amount of water that the tourism industry consumes, there is damage that is being done to Bali's water table that is irreversible, which could allow salt water to contaminate fresh water wells.

Tourism has had a positive impact on GDRP over the past decade. These impacts include the creation of new jobs and developing new infrastructure. There are also noticeable hardships that have mainly impacted the local community. This includes inequitable income distribution, over reliance on tourism as an industry, and less opportunities for small and local businesses to succeed. If Bali continues to neglect to enforce the rules of water management, the island will continue down an unsustainable path. This will create a very different Bali in years to come, making it difficult to preserve its environment while maintaining the same experience for people to enjoy for generations in the future.

References

- Cole, S. (2013). Tourism and water: from stakeholders to rights holders, and what tourism businesses need to do. *Journal of Sustainable Tourism*, 22(1), 89–106.
<https://doi.org/10.1080/09669582.2013.776062>
- Cole, S., & Browne, M. (2015). Tourism and Water Inequity in Bali: A Social-Ecological Systems Analysis. *Human Ecology*, 43(3), 439–450.
<https://doi.org/10.1007/s10745-015-9739-z>
- Huang, H. (2020). Issue 2 Bali Article 1 2-7-2020 Bali. *EnviroLab Asia EnviroLab Asia*, 3(2).
- Indonesia: Bali GDRP by sector. (n.d.). Statista. Retrieved April 19, 2024, from
<https://www.statista.com/statistics/1357088/indonesia-bali-gdrp-by-sector/>
- Indonesia: Bali GDRP distribution by sector. (2024, February 1). Statista.
<https://www.statista.com/statistics/1357111/indonesia-bali-gdrp-distribution-by-sector/>
- Indonesia: Bali population projection by regency 2023. (n.d.). Statista.
<https://www.statista.com/statistics/1361156/indonesia-bali-population-projection-by-regency-2023/#:~:text=Population%20projection%20in%20Bali%20Indonesia%202023%2C%20by%20regency&text=By%202023%2C%20the%20population%20in>
- Linton, J. (2013). Modern water and its discontents: a history of hydrosocial renewal. *WIREs Water*, 1(1), 111–120. <https://doi.org/10.1002/wat2.1009>
- Mahadevan, R., Amir, H., & Nugroho, A. (2016). Regional impacts of tourism-led growth on poverty and income inequality. *Tourism Economics*, 23(3), 614–631.
<https://doi.org/10.5367/te.2015.0534>

Nurhayati-Wolff, H. (2022, February 25). *Indonesia: number of foreign tourist arrivals to Bali 2018*. Statista.

<https://www.statista.com/statistics/976842/foreign-tourist-arrivals-numbers-bali-indonesia/>

Rimba, A. B., Mohan, G., Chapagain, S. K., Arumansawang, A., Payus, C., Fukushi, K., Husnayaen, Osawa, T., & Avtar, R. (2021). Impact of population growth and land use and land cover (LULC) changes on water quality in tourism-dependent economies using a geographically weighted regression approach. *Environmental Science and Pollution Research*, 28(20), 25920–25938. <https://doi.org/10.1007/s11356-020-12285-8>

Rimba, A., Chapagain, S., Masago, Y., Fukushi, K., & Mohan, G. (2019). *INVESTIGATING WATER SUSTAINABILITY AND LAND USE/LAND COVER CHANGE (LULC) AS THE IMPACT OF TOURISM ACTIVITY IN BALI, INDONESIA*.

Ritter, K. (2019, December 9). *HotSpots H2O: Rivers Run Dry in Bali as Tourism, Drought, Overwhelm Water Supply*. Circle of Blue.

<https://www.circleofblue.org/2019/hotspots/hotspots-h2o-rivers-run-dry-in-bali-as-tourism-drought-overwhelm-water-supply/>

Smith, J. (2018, February 26). *Bali's Tourism Is Sucking The Island Dry*. www.vice.com.

<https://www.vice.com/en/article/qvexem/balis-tourism-is-sucking-the-island-dry>

Sutawa, G. K. (2012). Issues on Bali Tourism Development and Community Empowerment to Support Sustainable Tourism Development. *Procedia Economics and Finance*, 4, 413–422. [https://doi.org/10.1016/s2212-5671\(12\)00356-5](https://doi.org/10.1016/s2212-5671(12)00356-5)