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Assessment of Potential Damage and Loss of Subak Land Use Due to Flood Hazard in South Denpasar District, Denpasar City

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Abstrak

Kecamatan Denpasar Selatan memiliki ketinggian 0–12 meter di atas permukaan laut dan dikategorikan sebagai daerah dataran rendah, sehingga rawan terhadap bencana banjir. Banjir dapat menyebabkan kerusakan dan kerugian ekonomi, terutama di sektor pertanian di lahan subak. Penelitian ini bertujuan untuk menghitung potensi kerusakan dan kerugian dalam penggunaan lahan subak di Denpasar Selatan. Metode yang digunakan meliputi Indeks Kebasahan Topografi (TWI) untuk menganalisis potensi banjir dan kerusakan, serta survei lapangan untuk validasi dan estimasi kerugian. Data yang digunakan meliputi data DEM SRTM, peta Rupabumi Indonesia (RBI), data peta batas subak Kecamatan Denpasar Selatan, citra satelit yang berasal dari google satellite. Data dari Dinas Pertanian meliputi data luasan subak. Data dari Balai Penyuluh Pertanian (BPP) dan pekaseh subak meliputi data komponen harga biaya produksi subak per hektar. Data dari Dinas Pekerjaan Umum bagian Sumber Daya Air meliputi data irigasi subak dan komponen harga dalam pembuatan irigasi beton per meter. Hasil penelitian menunjukkan bahwa lahan subak di Denpasar Selatan memiliki potensi kerusakan tinggi meliputi 91.732 ha (20,48%), potensi kerusakan sedang sebesar 133.548 ha (29,81%), dan rendah atau tidak ada kerusakan sebesar 222.701 ha (49,71%). Daerah dengan potensi kerusakan subak terbesar adalah Subak Kerdung dan Subak Kepaon. Potensi kerusakan jaringan irigasi subak diklasifikasikan sebagai tinggi 974,07 m (8,00%), sedang 4.107,12 m (33,71%), dan rendah atau tidak ada 7.101,99 m (58,29%). Potensi kerusakan irigasi terpanjang ditemukan di Subak Kerdung dan Subak Intaran Barat. Total estimasi kerugian subak di Kecamatan Denpasar Selatan dihitung dengan menjumlahkan kerugian dari potensi kerusakan tinggi dan sedang untuk setiap variabel. Estimasi kerugian untuk produksi subak adalah Rp 1.564.288.000, sedangkan kerugian irigasi adalah Rp 1.496.626.727, sehingga total potensi kerugian adalah Rp 3.060.914.727. Kerugian tertinggi ditemukan di Subak Kerdung dan Subak Kepaon. Rekomendasi kebijakan meliputi penguatan infrastruktur irigasi, pelatihan mitigasi bencana, dan pelestarian sistem subak melalui konservasi lahan.

Abstract

South Denpasar District has an elevation of 0–12 meters above sea level and is categorized as a lowland area, making it prone to flood disasters. Flooding can cause damage and economic losses, particularly in the agricultural sector on subak lands. This study aims to calculate the potential damage and losses in subak land use in South Denpasar. The methods used include the Topographic Wetness Index (TWI) to analyze flood and damage potential, as well as field surveys for validation and loss estimation. The data used include DEM SRTM data, the Indonesian Topographic Map (RBI), the subak boundary map of South Denpasar District, and satellite imagery from Google Satellite. Data from the Department of Agriculture include subak area data. Data from the Agricultural Extension Center (BPP) and subak heads (*pekaseh*) include data on the cost components of subak production per hectare. Data from the Department of Public Works, Water Resources Division, include subak irrigation data and the cost components for constructing concrete irrigation channels per meter. The results show that subak land in South Denpasar has high damage potential covering 91,732 ha (20,48%), medium damage potential at 133,548 ha (29,81%), and low or no damage at 222,701 ha (49,71%).

Areas with the largest subak damage potential are Subak Kerdung and Subak Kepaon. The potential damage to subak irrigation networks is classified as high 974,07 m (8,00%), medium 4.107,12 m (33,71%), and low or none 7.101,99 m (58,29%). The longest irrigation damage potentials are found in Subak Kerdung and Subak Intaran Barat. The total estimated subak loss in South Denpasar District is calculated by summing the losses from high and medium damage potential for each variable. The estimated loss for subak production is IDR 1,564,288,000, while the irrigation loss is IDR 1,496,626,727, resulting in a total potential loss of IDR 3,060,914,727. The highest losses are found in Subak Kerdung and Subak Kepaon. Policy recommendations include strengthening irrigation infrastructure, disaster mitigation training, and preserving the subak system through land conservation.

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INTRODUCTION

Indonesia is a country located in the tropics with a diverse topography that is vulnerable to various kinds of natural events, especially floods. Flood can also be interpreted as a water runoff that exceeds the normal water level (Almuthorri, 2017). Floods that occur are caused by several factors such as poor drainage systems and high rainfall.

Floods are the most frequent natural disaster in Indonesia, both in terms of intensity in a place and the number of locations of occurrence in a year, which is around 40% among other natural disasters such as earthquakes, landslides, tsunamis and volcanic eruptions (Putra, 2017). Floods that occur can have an impact on several aspects of agriculture that cause damage and losses, such as damage to irrigation, agricultural land and losses caused by a decrease in agricultural production.

One of the areas that is potentially prone to flooding is South Denpasar District, which is located in the City of Denpasar and has an elevation ranging from 0 to 12 meters above sea level. In December 2021, floods occurred in several locations, namely Pedungan Subdistrict, Pemogan Village, Sanur Kaja Village, Sesetan Subdistrict, and Panjer Subdistrict, due to heavy rainfall in the area. Flooding has also previously occurred in one of the subak areas in South Denpasar District, namely Subak Renon, which experienced flooding during the harvest season in March 2023. This was caused by several days of continuous rain that resulted in overflowing water due to a collapsed wall in the water channel, leading to crop failure. Floods can cause damage and losses in the agricultural sector, especially in subak lands. *Subak* is a traditional farmer organization in Bali that regulates the irrigation system for farming and agricultural activities (Wigena, 2019).

South Denpasar District is one of the several districts in the City of Denpasar, covering a total area of 49.99 km², which accounts for approximately 39.12% of the total city area. It consists of 4 villages (Pemogan Village, Sanur Kaja Village, Sanur Kauh Village, Sidakarya Village) and 6 subdistricts (Panjer, Pedungan, Renon, Sanur, Serangan, and Sesetan Subdistricts). One of the leading agricultural products in South Denpasar District is food crops, particularly rice. To prevent severe damage and significant losses, it is necessary to regularly assess the potential for land damage and loss.

Making a map of potential damage and potential loss of subak land needs to be done in order to determine the potential for damage and loss of subak land use and the current status of damage and loss by using Geographic Information System (GIS) applications by using the TWI (Topographic Wetness Index) method which is a method of quantifying control over hydrological processes in an area by taking into account topographic conditions based on differences in elevation and slope of the land surface (Santoso *et al*, 2023). This study is a continuation of Mahfudz's (2022) research, which mapped flood-prone areas in Cigudeg District, Bogor Regency, using the TWI method.

Several researchers have widely used the TWI method to detect flood-prone areas. For instance, Nucifera et al. (2017) detected flood vulnerability in Kebumen Regency. Pourali (2014) successfully assessed flood risk for land-use planning in Wreck Creek, Australia. Santoso et al. (2023) applied TWI to study flood hazard potential in Manado City. Aksoy (2016) used TWI as one of the parameters in modeling flood vulnerability to determine areas prone to waterlogging. Haas (2010) employed TWI in soil moisture modeling, indirectly illustrating land wetness values related to soil moisture. TWI (Topographic Wetness Index) quantitatively assesses the effect of local topography on stormwater runoff. TWI values will describe the tendency of water accumulation on a slope based on the gravitational forces that control water flow. Mapping the potential occurrence of damage and loss of subak land can determine appropriate rice field management actions so that damage and loss can be prevented and repaired.

METHODS

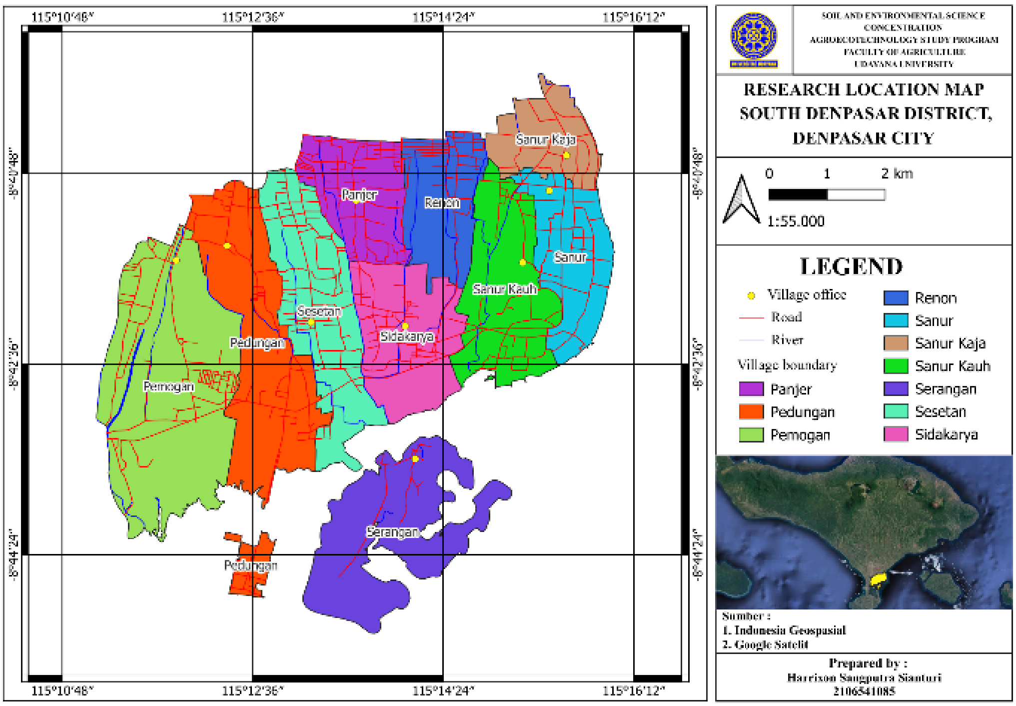

Figure 1. Map of the research location

This research was conducted from October 2024 to February 2025. The location of the research area is South Denpasar District, Denpasar City, Bali Province. To the north, South Denpasar Subdistrict is bordered by North Denpasar Subdistrict, to the south by Kuta Subdistrict, to the west by West Denpasar Subdistrict, to the east by the Bali Sea.

The method used in this research uses quantitative-qualitative research methods accompanied by field surveys to determine the validation of flood potential mapping results. Secondary data and primary data were analyzed and integrated into maps using Geographic Information System (GIS). The Topographic Wetness Index (TWI) method utilized for analyzing hydrology and describing the tendency of an area to accumulate water by considering several research parameters. The selection of research parameters is based on research criteria related to the potential damage and losses on subak land and subak irrigation due to flood hazards adapted to the characteristics of the study area.

The research stage is the primary data collection stage with direct interviews with subak leaders and field observations to find out the condition of the location when exposed to flooding and secondary data obtained from several sources and agencies such as data from Indonesia Geospatial which includes DEM (SRTM) data (Digital Elevation Model Shuttle Radar Topography Mission) from the year 2024, Indonesian Rupabumi map (RBI) from the year 2024, subak boundary map data of South Denpasar District from the year 2024. Satellite imagery from 2024 obtained from Google Satellite to virtually visualize the actual conditions in the field. Data from the Agriculture Office from the year 2024 includes subak area data. Data from the Agricultural Extension Center (BPP) and subak pekaseh from the year 2024 include data on the price component of subak production costs per hectare. Data from the Water Resources section of the Public Works Department from the year 2024 includes data on subak irrigation and the price components of concrete irrigation per meter.

Before processing the map, geometric correction is performed to align it with the actual earth coordinates. The administrative boundaries in each map dataset to be used are corrected by performing re-delineation of the map boundaries. Data processing begins with processing DEM (SRTM) data using Geographic Information Systems (GIS) with the QGIS application.

This analysis uses the TWI (Topographic Wetness Index*)* method which aims to determine flood potential by measuring the ability of an area to retain water based on differences in elevation and slope of the land surface. The use of this method produces a map of flood potential in the area under study. Based on Beven and Kirby (1979), the main formula used to calculate TWI is as follows:

$$TWI = In\left(\frac{A}{\tan(\beta)}\right)$$

Description:
A: Flow area per unit area of each landscape point (m^2/m)
β: Slope in degrees

The results of the analysis of the distribution of TWI (Topographic Wetness Index) which is already known in each subak area, then classified by the quantile method into 3 classes, namely low (no), medium, and high classes. This TWI distribution represents the potential damage to subak land that occurs due to flooding. The higher the TWI value proves that an area has a large contribution of slope so that water is easily accumulated and may not be able to seep into the soil. The lower the TWI value proves that an area has a small slope contribution so that water does not accumulate and is easier to seep down.

Processing of subak boundary data and subak irrigation data with satellite imagery using the QGIS application by delineating the subak irrigation map and re-delineating the subak boundary map so as to obtain the latest subak boundary map and subak irrigation map. After obtaining the map of potential flood areas, the subak boundary map and the latest subak irrigation map, then intersect (overlap) so as to get a map of potential flood areas in subak and subak irrigation.

Potential production losses for each potentially flooded subak were calculated based on data on the cost price component of subak production costs per hectare. The calculation of potential losses is based on the price component of subak production costs per hectare and the amount of potential damage to the subak. The calculation of potential production losses for each subak with flood potential can be calculated using the following formula:

$$Pi = Ki \ x \ P$$

Description:
Pi: Potential loss of subak irrigation
Ki: Price component in irrigation manufacturing per meter
P: Length of potential damage

Potential loss data was classified using the quantile method into 3 classes, namely low/no, medium, and high classes in GIS based on the research variables, resulting in a potential loss map.

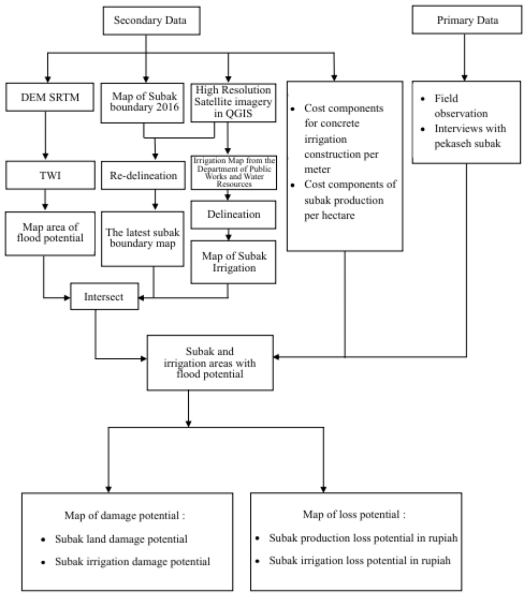

Figure 2. Research data processing flowchart

RESULT AND DISCUSSION

Based on data from the Denpasar City Agriculture Office in 2024, South Denpasar District currently has 10 subak areas with a total area of 447 ha. Subak land in South Denpasar District is currently experiencing high land conversion into settlements. The significant increase in population is the reason for the high land use change so that the construction of settlements can also affect the change of function of subak irrigation which initially irrigation functioned for irrigating rice fields then after the existence of settlements, the subak irrigation became cut off by permanent buildings and became a household waste disposal channel so that it could have a negative impact on the irrigation system. The length of subak irrigation is based on data from the Denpasar City Public Works Office Water Resources section in 2024 and the results of the analysis using QGIS, South Denpasar District currently has an irrigation length of approximately 12,183.18 m. This is the sum of each subak irrigation length. This is the summation of each irrigation length that exists in each subak today. With this high rate of land use change and irrigation use change, subak land is vulnerable to flooding when it rains because the irrigation canals are no longer able to accommodate high water discharge and the land absorption area of subak land has been reduced so that it can cause damage and losses to subak when flooding occurs.

Based on the results of TWI analysis and mapping in South Denpasar sub-district, the minimum TWI value is 7.641149 and the maximum value is 25.099533 presented in Table 1. With this range of values, it is classified into 3 classes with the quantile method. The low/no class has a TWI value range of 7.641149 to 10.961508. The medium class has a TWI value range of 10.961509 to 12.285085. The high class has a TWI value range of 12.285086 to 25.099533. Based on the TWI value class data, it produces a TWI map which is the distribution of potential damage to subak land due to flooding presented in Figure 3.

Table 1. TWI Distribution Value in Subak

TWI Value	Class
7,641149 - 10,961508	Low/No
10,961509 - 12,285085	Medium
12,285086 - 25,099533	High

Source: DEM Data Processing with QGIS (2025)

Table 2. Area and Percentage of Potential Subak Damage

No	Subak Name	Area (Ha)			Area (%)		
		High	Medium	Low	High	Medium	Low
1	Sanur	6,085	10,380	16,135	1,36%	2,32%	3,60%
2	Intaran Barat	15,340	21,766	42,237	3,42%	4,86%	9,43%
3	Intaran Timur	2,511	2,480	5,939	0,56%	0,55%	1,33%
4	Renon	8,751	11,793	19,565	1,95%	2,63%	4,37%
5	Panjer	1,477	1,122	2,251	0,33%	0,25%	0,50%
6	Sesetan	1,040	1,080	2,161	0,23%	0,24%	0,48%
7	Sidakarya	7,271	10,167	20,421	1,62%	2,27%	4,56%
8	Kerdung	26,238	37,749	59,451	5,86%	8,43%	13,27%
9	Kepaon	15,975	24,397	34,701	3,57%	5,45%	7,75%
10	Cuculan	7,044	12,614	19,840	1,57%	2,82%	4,43%
Total		91,732	133,548	222,701	20,48%	29,81%	49,71%
Grand Total		447,981 Ha			100 %		

Source: Results of Overlay Analysis of TWI Map and Subak Boundary Map on QGIS (2025)

The results of the TWI analysis of the subak indicate that some subak have topographic characteristics that are more vulnerable to inundation and flooding. Subak Kerdung has a high TWI value with the largest area of 26,238 ha (5.86%), followed by Subak Kepaon with an area of 15,975 ha (3.57%) and Subak Intaran Barat with an area of 15,340 ha (3.42%) which indicates that these areas have a tendency to experience inundation that can cause damage to subak land.

Overall, 91.732 ha (20.48%) of subak land in South Denpasar sub-district has a high potential for damage and 113.548 ha (29.81%) of subak land has a medium potential for damage. Data on the extent and percentage of subak damage potential is presented in Table 2.

Subak irrigation system is an important component in the sustainability of subak. The results of the TWI map overlay analysis with the subak irrigation map in QGIS obtained the distribution of potential damage to subak irrigation due to flooding presented in Figure 4. Data on the length and percentage of potential damage to subak irrigation are presented in Table 3. Of the total 12,183.18 m length of subak irrigation, about 974.07 m (8%) has high potential damage and 4,107.12 m (33.71%) has medium potential damage.

The subak irrigation with the largest potential for high damage class is Subak Kerdung with 246.63 m (2.02%), followed by Subak Intaran Barat with 227.83 m (1.87%) and Subak Renon with 117.91 m (0.97%). This indicates that most subak irrigation infrastructure is vulnerable to flood damage. This could exacerbate the impact of flooding on subak lands.

Table 3. Length and Percentage of Potential Damage to Subak Irrigation

No.	Subak Name	Length (m)			Length (%)		
		High	**Medium**	**Low**	**High**	**Medium**	**Low**
1.	Sanur	42,39	350,90	689,75	0,35%	2,88%	5,66%
2.	Intaran Barat	227,83	540,64	1.188,79	1,87%	4,44%	9,76%
3.	Intaran Timur	76,17	161,27	275,75	0,63%	1,32%	2,26%
4.	Renon	117,91	706,53	1.069,14	0,97%	5,80%	8,78%
5.	Panjer	47,27	34,84	171,41	0,39%	0,29%	1,41%
6.	Sesetan	8,34	67,37	126,41	0,07%	0,55%	1,04%
7.	Sidakarya	49,37	245,78	291,36	0,41%	2,02%	2,39%
8.	Kerdung	246,63	778,07	1.240,84	2,02%	6,39%	10,18%
9.	Kepaon	93,18	854,97	1.210,12	0,76%	7,02%	9,93%
10.	Cuculan	64,97	366,75	838,44	0,53%	3,01%	6,88%
Total		974,07	4.107,12	7.101,99	8,00%	33,71%	58,29%
Grand Total		12.183,18 m			100 %		

Source: Results of Overlay Analysis of TWI Map and Subak Irrigation Map on QGIS (2025)

Based on data from BPP South Denpasar and Interview Pekaseh Subak, then obtained data on the components of rice production costs per hectare consisting of the cost components needed in one rice production process. In this study only uses rice crop production because the average farmer only grows rice, but other crops such as secondary crops only occasionally and on average do not sell and only for their own consumption. This data is based on the situation in the field when there was a flood which at the time of the flood, the average rice cultivation process was still only up to the fertilization stage and not up to the stage of pest and disease control (spraying pesticides). Then the total price of production costs required per hectare is around Rp6,943,750. Using this value, the potential production loss in the high class is around Rp636,964,075 and the potential loss in the medium class is around Rp927,323,925. The highest potential loss in the high class is Subak Kerdung with a potential loss of Rp182,190,113 followed by Subak Kepaon with a potential loss of Rp110,926,406 and Subak Intaran Barat with a potential loss of Rp106,517,125.

Data on potential subak production losses are presented in Table 4. Such production losses are likely to have a direct impact on farmers' income. Given that subak agriculture is the main source of income for many farming families, these losses could threaten their welfare. In the field survey results, if the flooded rice plants can still be repaired, the damaged rice plants will be replanted. If the rice crop on the subak farm is completely damaged, the loss is assisted by insurance at 10% of the initial cost incurred.

Based on data from the Denpasar City Public Works Department of Water Resources, data on the price component of irrigation per meter was obtained. This data is based on the work of a subak irrigation in Denpasar City. The total price of irrigation per meter is around Rp294,543.14. In the field data, the average subak irrigation has a size that is less wide because when the rain is large and the water discharge increases the irrigation is not able to accommodate and drain the water properly. Based on data on the cost component of irrigation per meter that has been obtained from the Department of Public Works in the field of Water Resources, the cost of irrigation per meter is around Rp294,543.14. By using this cost, the potential loss of irrigation is known in the high class around Rp286,902,694 and the potential loss in the medium class around Rp1,209,724,033.

Data on potential irrigation losses are presented in Table 5. Potential irrigation losses in the high class most is Subak Kerdung with a potential loss of about Rp72,643,175, followed by Subak Intaran Barat with a potential loss of about Rp67,105,764 and Subak Renon with a potential loss of about Rp34,729,582. These losses can be a significant economic burden for local governments or farmer groups to recover the damage

Table 4. Potential Production Losses of Subak

No.	Subak Name	Production						Total	
		High		Medium		Low			
1.	Sanur	Rp	42.252.719	Rp	72.076.125	Rp	112.037.406	Rp	226.366.250
2.	Intaran Barat	Rp	106.517.125	Rp	151.137.663	Rp	293.283.169	Rp	550.937.956
3.	Intaran Timur	Rp	17.435.756	Rp	17.220.500	Rp	41.238.931	Rp	75.895.188
4.	Renon	Rp	60.764.756	Rp	81.887.644	Rp	135.854.469	Rp	278.506.869
5.	Panjer	Rp	10.255.919	Rp	7.790.888	Rp	15.630.381	Rp	33.677.188
6.	Sesetan	Rp	7.221.500	Rp	7.499.250	Rp	15.005.444	Rp	29.726.194
7.	Sidakarya	Rp	50.488.006	Rp	70.597.106	Rp	141.798.319	Rp	262.883.431
8.	Kerdung	Rp	182.190.113	Rp	262.119.619	Rp	412.812.881	Rp	857.122.613
9.	Kepaon	Rp	110.926.406	Rp	169.406.669	Rp	240.955.069	Rp	521.288.144
10.	Cuculan	Rp	48.911.775	Rp	87.588.463	Rp	137.764.000	Rp	274.264.238
	Total	Rp	636.964.075	Rp	927.323.925	Rp	1.546.380.069	Rp	3.110.668.069

Source: Data Processing Results (2025)

Table 5. Potential Irrigation Losses

No.	Subak Name	Irrigation						Total	
		High		Medium		Low			
1.	Sanur	Rp	12.485.684	Rp	103.355.189	Rp	203.161.133	Rp	319.002.005
2.	Intaran Barat	Rp	67.105.764	Rp	159.241.805	Rp	350.149.943	Rp	576.497.512
3.	Intaran Timur	Rp	22.435.351	Rp	47.500.973	Rp	81.220.272	Rp	151.156.595
4.	Renon	Rp	34.729.582	Rp	208.103.567	Rp	314.907.856	Rp	557.741.004
5.	Panjer	Rp	13.923.054	Rp	10.261.883	Rp	50.487.640	Rp	74.672.578
6.	Sesetan	Rp	2.456.490	Rp	19.843.372	Rp	37.233.199	Rp	59.533.060
7.	Sidakarya	Rp	14.541.595	Rp	72.392.814	Rp	85.818.090	Rp	172.752.499
8.	Kerdung	Rp	72.643.175	Rp	229.175.183	Rp	365.480.913	Rp	667.299.272
9.	Kepaon	Rp	27.445.530	Rp	251.825.551	Rp	356.432.548	Rp	635.703.629
10.	Cuculan	Rp	19.136.468	Rp	108.023.698	Rp	246.956.753	Rp	374.116.918
	Total	Rp	286.902.694	Rp	1.209.724.033	Rp	2.091.848.346	Rp	3.588.475.073

Source: Data Prcessing Results (2025)

Table 6. Potential Subak Losses

No.	Subak Name	Overall Potential Loss		Loss Class
1.	Sanur	Rp	230.169.716	Medium
2.	Intaran Barat	Rp	484.002.356	High
3.	Intaran Timur	Rp	104.592.580	Low
4.	Renon	Rp	385.485.549	Medium
5.	Panjer	Rp	42.231.744	Low
6.	Sesetan	Rp	37.020.611	Low
7.	Sidakarya	Rp	208.019.521	Low
8.	Kerdung	Rp	746.128.090	High
9.	Kepaon	Rp	559.604.156	High
10.	Cuculan	Rp	263.660.403	Medium
	Total	Rp	3.060.914.727	

Source: Data Prcessing Results (2025)

The calculation of the overall subak loss potential was calculated by summing the results of the calculation of high and medium class loss potential in each variable. The sum of high and medium class losses on potential subak production losses amounted to Rp1,564,288,000 and the sum of high and medium class losses on potential subak irrigation losses amounted to Rp1,496,626,727. Therefore, the total potential loss of subak is Rp3,060,914,727. The overall subak loss potential data is presented in Table 6. The highest potential loss is in Subak Kerdung with a total potential loss of Rp746,128,090, followed by Subak Kepaon with a total potential loss of Rp559,604,156 and Subak Intaran Barat with a total potential loss of Rp484,002,356. A map of the distribution of potential subak losses is presented in Figure 5.

In Mahfudz's (2022) study, the flood potential analysis in Cigudeg District, Bogor Regency, using the TWI method, only involved mapping the flood-prone areas. In contrast, this study maps the flood-prone areas and calculates the damage and economic losses to subak lands in South Denpasar District, Denpasar City, using the TWI method. For subak areas in South Denpasar Subdistrict, agricultural inputs (means of production) are good and complete and the storage of these inputs is also good so that when flooding occurs the inputs are not damaged. Based on the analysis of potential damage and losses that have been obtained, some adaptation and mitigation strategies that can be considered are improving irrigation infrastructure and strengthening irrigation construction for subaks with high TWI values such as Subak Kerdung, Kepaon, and West Intaran to reduce the risk of inundation and flooding, implementation of a flood early warning system that can help farmers take precautions to reduce losses by establishing conservation zones by the government to establish subak conservation zones that should not be converted, especially for subaks that have high historical and cultural value.

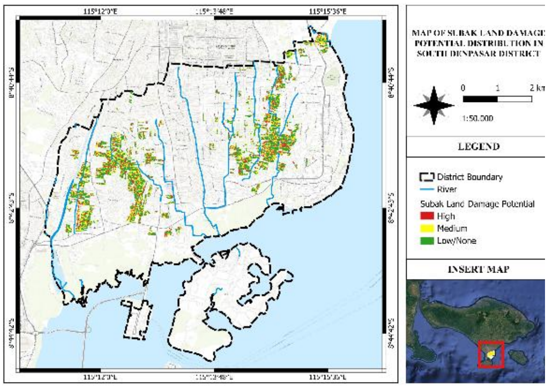

Figure 3. Map of the Distribution of Potential subak Land Damage (Overlay Analysis of TWI Map and Subak Boundary Map in QGIS, 2025)

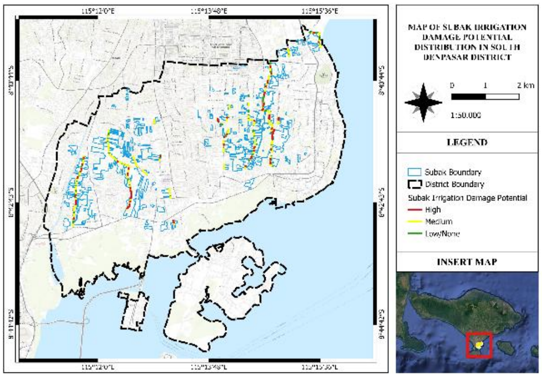

Figure 4. Distribution Map of Potential Damage to Subak Irrigation (Overlay Analysis of TWI Map and Subak Irrigation Map in QGIS, 2025)

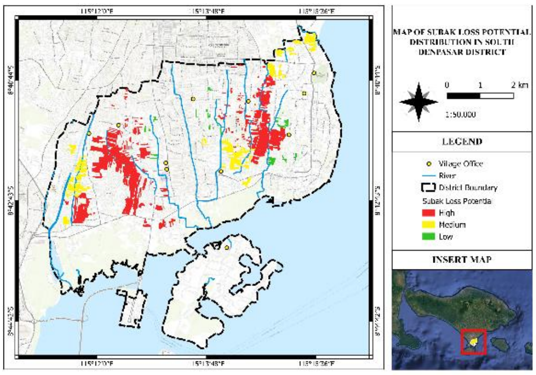

Figure 5. Distribution map of Subak potential losses (Classification of subak land loss potential in QGIS, 2025)

CONCLUSION

Based on the research results obtained, several conclusions can be drawn, namely the potential damage to subak land use in South Denpasar District, namely the potential damage to subak land and the potential damage to subak irrigation. The overall damage potential of high class subak land is about 91.732 ha (20.48%), medium class is about 133.548 ha (29.81%) and low/no class is about 222.701 ha (49.71%). The area that has the widest potential damage to subak is in Subak Kerdung with a potential damage area of 26,238 ha (5.86%), followed by Subak Kepaon covering 15,975 ha (3.57%) and Subak Intaran Barat covering 15,340 ha (3.42%). The overall damage potential of high class subak irrigation is about 974.07 m (8.00%), medium class about 4,107.12 m (33.71%) and low/no class about 7,101.99 m (58.29%). Subak irrigation that has the longest potential damage length is in Subak Kerdung along 246.63 m (2.02%), followed by Subak Intaran Barat along 227.83 m (1.87%) and Subak Renon along 117.91 m (0.97%).

The overall loss potential of subak is the result of calculating the potential loss of high class and medium class in each variable. The number of high and medium class losses in the potential loss of subak production amounted to Rp1,564,288,000 and the number of high and medium class losses in the potential loss of subak irrigation amounted to Rp1,496,626,727. So the overall potential loss of subak amounted to Rp3,060,914,727. Potential high loss class is in Subak Intaran Barat, Subak Kerdung and Subak Kepaon. Potential medium loss class is in Subak Sanur, Subak Renon and Subak Cuculan. Low loss class potential exists in Subak Intaran Timur, Subak Panjer, Subak Sesetan and Subak Sidakarya.

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