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Sensing to anticipate and manage
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GIS Application in Monitoring Climate & Global Warming Effects of Monasavu Reservoir
School of Geography, Earth Science and Environment, Geospatial Science Department
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INTRODUCTION

Hydroelectric dams are source of clean and green energy urgently needed as an alternative to fossil fuels to help resolve climate crisis. However there are few challenges arise from the construction of dams in some of the major river bodies, firstly, operation of dams influence (CO₂) carbon dioxide emission especially in tropical region. Secondly, according to (G.Abril et al, 2005) dams influence the emission of (CH₄) methane from the large amount of decaying organic matter retained in flooded reservoirs. In Monasavu, according to (Z hao, Liu et al. 2021), the immediate impact of the Dam construction will be the increased sedimentation which on the other hand river sedimentation is also a major influence of carbon and methane emission.

Data Gathering

1. Sentinel-1 SAR Data (2015-2016)

2. Sentinel-2 Optical Data (2015-2016)

3. Digital Elevation Model (DEM)

4. Topographic Data

Data Processing


1. Terrain Correction

2. Create Subsets

3. Create Stack

4. Create RGB Composite

The snip below is showing the different processes undertaken using the SNAP software to derive the flooding extent of the Monasavu Reservoir in between 2015 and 2016.



1. Terrain Correction
2. Create Subset
3. Create Stack
4. Create RGB Composite

GIS MANAGEMENT APPROACH

GIS GLOBAL WARMING MANAGEMENT APPROACH


- Help Map Forest Carbon to determine how much or how dams interfere of flooding forest contribute to global warming.
- Map the amount of Deforestation or vegetation loss to trigger the movement of afforestation.

RESEARCH OBJECTIVES

- Outline the impacts of dams on climate
- Outline environmental challenges induced by dams
- Demonstrate the use of GIS application in monitoring climate change and global warming.


BACKGROUND

MONASAVU RESERVOIR



RESULTS, GRAPHS & MAPS

Monasavu Flood Map

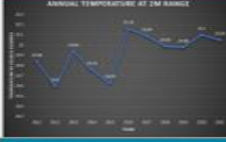


Legend

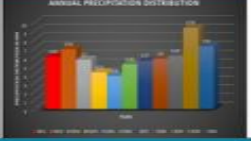
■ Flooded Area

Author: Maivunijale Waqa Date: 11/11/2022

ANNUAL TEMPERATURE AT 2M RANGE



ANNUAL PRECIPITATION DISTRIBUTION



DISCUSSION

This analysis aim is to highlight the impacts of dam or reservoirs construction on the climate and how it contributes to the warming up of our specific environment. Firstly, the Monasavu flooded Map was created using 2 sentinel radar imagery one from June 2015 (archive) and one from Dec 2016 (crisis), which both has a vertical (VV) polarization and same satellite orbital status acquired from Copernicus data hub. The areas symbolized in red on the map, illustrates the areas that usually flooded in between 2015 and 2016. These are the areas that mostly contribute to the emission of methane. Secondly, submerging of forest in the Monasavu area has led to uncertainty in precipitation distribution overtime which altered the climate and also the temperature and surface temperature of the area (surface and soil radiance). The submerging of forest, flooding of vegetated areas and global warming are highly correlated, where submerging of vegetation or forest led to the decaying of organic matter in which when they get exposed to the sun, the chemical bond retained during flooding which is methane evaporates in to the atmosphere contributing to increase in temperature. This is a long term process which happens overtime. To conclude, this is just a simple analysis in which GIS application can help manage global warming.

REFERENCE

1. Copernicus Open Access Hub
2. Power Data Access Viewer
3. G. Abril et al., "Carbon Dioxide and Methane Emissions and the Carbon Budget of a 10-Year Old Tropical Reservoir (Petit Saut, French Guiana)," Global Biogeochemical Cycles 19, GB4007 (2005).
4. Zhao, Y., et al. (2021). "Impacts of dams and reservoirs on local climate change: a global perspective." Environmental Research Letters 16(10).

METHODOLOGY

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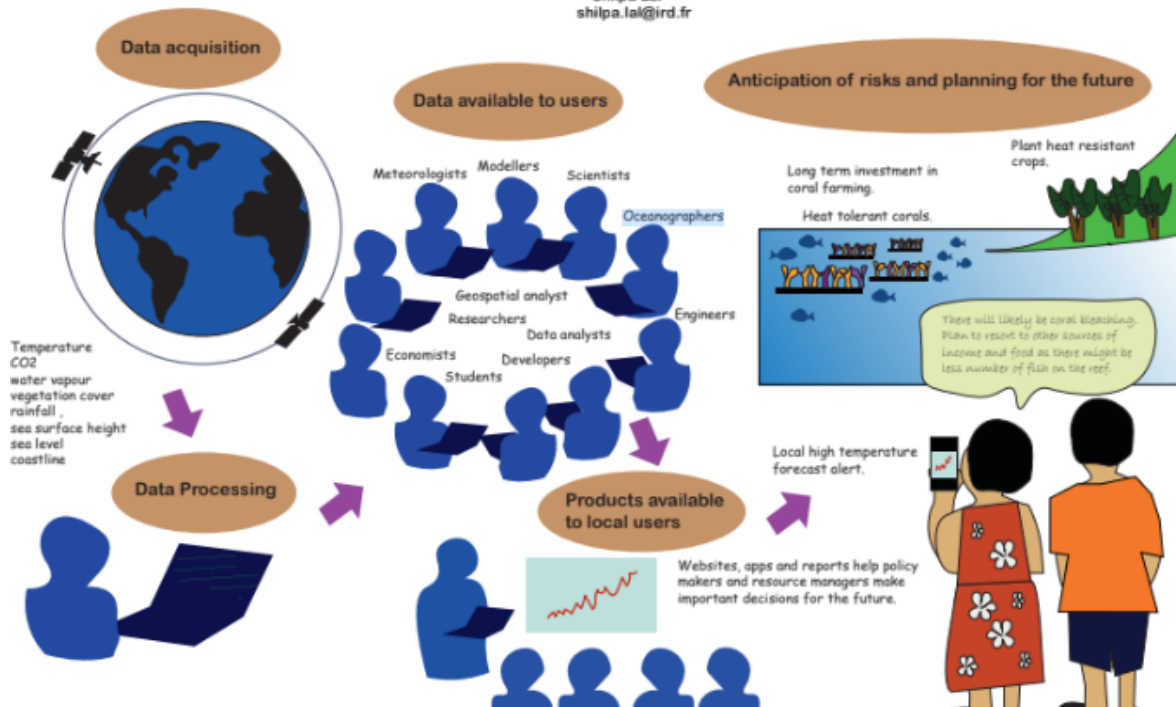


Shilpa LAL

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Digital Platforms, GIS and Remote Sensing to Anticipate and Manage Impacts of Global Warming

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Amrit Raj

PROFESSIONAL COMPETITION THIRD PLACE

Changes at the Mouth of the Avon-Heathcote Estuary in Christchurch, New Zealand

Amrit Raj (ara126@ucv.ac.nz)



Introduction

The Avon-Heathcote Estuary is regarded as one of the city's sites of exceptional biodiversity value within Christchurch and Banks Peninsula areas. It, along with the adjacent subtidal environments, is vital for water birds, with nationally and internationally significant concentrations of wetland and coastal birds in the area at times. The high proportion and importance of the wetland and coastal bird species make the "Heathcote City area" the "wetland capital of New Zealand".

The Avon-Heathcote Estuary (AHE) silt-tidal delta, these cross-sectional area and tidal prism may be out of equilibrium due to post-Canterbury Earthquake Sequence (CES) bathymetry change (Mousses et al. 2011, Mousses & Bird 2013), or it may be in a state of continual adjustment (dynamic equilibrium). The history of AHE geomorphology is discussed in Peadar and Kirk (1988) who estimate from the changes in the estuary mouth cross-section that the "tidal competence" (hereafter, tidal prism) of the Avon-Heathcote Estuary has been increasing over time, supplying net erosion and sediment export to the coast. Thompson (1994) examined the silt tidal delta, South Brighton spit and inlet morphology using camera and beach profiles, attributing a one case profile change to effective tidal flushing of sediment out of the estuary.

The research project will include analysing shoreline and cross-section change, the significance of sediment transport (including fluvial sediment) and ebb or flood dominance. The shoreline changes around the estuary mouth are crucial data for understanding sea, spit and beach have transformed in recent years.



Figure 1 - Aerial view of the Avon-Heathcote Estuary showing the mouth and surrounding land.

Methodology

Existing Data Set
 Profiles (Thompson 1994)
 Aerial Photos (LINZ data service 2014)
 Tides (CC and LINZ 2015)
 DEM (Mousses et al. 2011, 2013)

Remotely Aerial Vehicle via Photogrammetry
 In this project, a UAV (drone) was flown at the Avon-Heathcote Estuary at low tide to capture images of the estuary mouth, tidal flat delta, and mid of the spit as shown in the study area map (Figure 1). The UAV used was an ArduPilot KITE G2 on board with a DJI X5C 2. Major features which provides real-time differential data to the drone. There is a base station using, correcting data in real time (Figure 2). Ground Control Point (GCP) markers will be used to determine the accuracy of data after processing the UAV images as a check. Processing is done using Pix4D Mapper and Trimble Business Center (TBC).

Beach Profiles and Bathymetry
 Beach profiles are collected using the integrated high precision Real Time Kinematic GPS positioning system. The beach profile will be compared with existing data to detect changes. Bathymetry data is collected using a remote-controlled jet boat with sound depth sounder linked to a GPS benchmark on land. Transverse across the estuary mouth were surveyed at high tide. All the data are converted to New Zealand Vertical Datum 2000 (NZVD2000) for comparison with the existing data set.

Result

Data processing of the UAV data was processed using 15 days trial version of Pix4Dmapper software. There is a total of 567 images processed from 2 flights flown at the height of 100m. There are multiple outputs such as the generation of geo-referenced orthomosaic, DSM, 10 meter cloud and textured mesh models in a variety of formats. The ground sampling distance (GSD) for the ortho-mosaic is 1cm.



Figure 3 - Map showing the ortho-mosaic of the estuary mouth and beach profiles.

The beach profile data will be compared with Thompson (1994) profile to able to look at changes. The time with Thompson profile was the absence of geo-location for the starting point of the profiles.

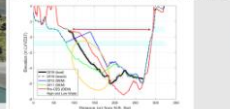


Figure 4 - Profile compared to existing DEM (2011, 2013) and bathymetry. The profile shows the elevation has change by 2 meters compared to 2013. The main channel is shallower compared pre-quake and has become wider (Figure 4).

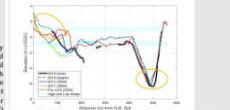


Figure 5 - Beach Profile compared to existing DEM (2011, 2013) and bathymetry. The profile shows that the main channel is stable and has not moved since the earthquake. The beach here has increased by 2 metres in elevation. Large sand bar after the CES is now eroding back down. From cross-section extracted from the bathymetry survey of the mouth of the estuary by NWA, show that the mouth cross-section shape and area varied significantly since the earthquake (Figure 5).



Figure 6 - Beach Profile compared to existing DEM (2011, 2013) and bathymetry. The profile shows that the main channel is stable and has not moved since the earthquake. The beach here has increased by 2 metres in elevation. Large sand bar after the CES is now eroding back down. From cross-section extracted from the bathymetry survey of the mouth of the estuary by NWA, show that the mouth cross-section shape and area varied significantly since the earthquake (Figure 5).

Discussion

Shoreline changes occur over a wide range of time scales and linked with coastal features such as waves, tides, periodic storms, sea level rise (SLR), and human developmental activities (Appropria Adde et al. 2008). The shoreline position can transform due to predictable shoreline variations in sea level that rely on astronomical and meteorological factors (Pugh 2004) and less predictable changes in the form and volume of the sediments along the profile of the shore (Pardo-Pascual et al. 2012).

For the shoreline analysis, vegetation line was used (Brink and Turner 2002) since it was not possible to obtain pre-existing shoreline dataset.

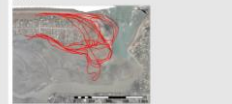


Figure 8 - 1947-2005 by shoreline (from Peadar and Kirk 1988 and Bryan et al. 2008).

The rate of net shoreline movement from 2004 to 2013 range from -25.26 m to 18.57 m, where negative values represent erosion, and positive values represent accretion, as shown in Figure 10.

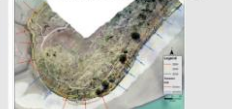


Figure 9 - Transverse cut showing accretion (blue) and erosion (red) on the South Spit.



Figure 10 - Illustrates the bathymetry 3.0 and 5 into the estuary in eroding, and the erosion rate ranged from 4.2 to 1.3 m/year for the past 10 years. The rate shoreline erosion is 1.3 m/year since 2004.



Figure 11 - Showing the erosion and accretion of the estuary mouth.

Conclusion

To conclude from the beach profiles, Clifton Beach at the mouth seems accreted, but dunes on the spit side were eroding at a rate of 1-1.3 m/year since 2004. Mouton Bay another has gone down back to a pre-

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Reuben Vulawalu

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