A PROJECT ON

LAND COVER CLASSIFICATION OF THE AUSTRALIAN BUSHLANDS BEFORE AND AFTER THE SEPTEMBER 2019 – MARCH 2020 BUSHFIRES

BY PRAVALIKA RAVULA

923106883

GEOG711

PROF. LEONHARD BLESIUS

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INTRODUCTION:

The Australian bushlands are best known for their unique biodiversity, ecological significance and breathtaking lansdscapes. However, the massive bushfires that occurred in the month of September 2019 and lasted till March 2020 wreaked unimaginable havoc on these ecosystems. The main reasons for these fires include droughts, decline in rainfall and climate change. The cataclysmic impact by these fires made it urgently necessary to evaluate and comprehend the modifications to the classification of land cover that occurred as a result of this terrible incident. The Australian bushlands were known for their diverse land cover types before the bushfires, which supported a broad variety of ecosystems, flora and fauna. The vegetation in these places was mosaic, with forests and woods serving as important habitats for a wide variety of plant and animal species. The bushlands were essential for storing carbon, controlling river flow, and providing habitat for rare animals. The intensity and extent of bushfires resulted in large-scale destruction of vegetation, significant habitat loss, and vast alterations in the land cover patterns.

The project delves to utilize eCognition to analyse the pre and post fire satellite imagery, enabling a detailed interpretation of the changes in land cover classification using object based image analysis. By using sophisticated image processing algorithms, the softaware will identify and classify different land cover types based on their spectral and spatial characteristics. This will give a comprehensive understanding of the changes in vegetataion density and potential shifts in land use following the bush fires.

STUDY AREA:

Most part of the study area covers the Tamboon, Mallacoota, Chandlers Creek, Noorinee, Club Terrace regions, and Wallagaraugh River which are located on or near the coastal part of

Victoria state of Australia. Coopracambra National Park, Erriundra National Park, Point Hicks Marine National Park, and Croajingolong National Park are the major biodiversity areas covering in the project. Located in the East Gippsland region of Victoria, this area is renowned for its stunning natural beauty, rich biodiversity, and ecological significance. The border regions of New South Wales that include Nadgee, Timbillica and Yambulla are partly covered in the research. Mallacoota, situated on the edge of the Mallacoota Inlet, is surrounded by lush forest, estuaries and sandy beaches. Tamboon on the other hand is characterized by rugged landscape, dense forests and meandering rivers. Both the towns offers a unique blend of coastal and bushland ecosystem with a variety of native wildlife apecies, contributing to the overall ecological richness of the area.

The national parks contribute to a diverse habitat for several threatened species. Point Hicks Marine National Park, located along the coast, protects important marine habitats and supports a wide variety of marine life. Encompassing these significant national parks in the study area would help in understanding the immediate need for conservation and management of the unique habitats, addressing the challenges posed by man-made and natural disasters and promote sustainable practices for benefit of both nature and human communities.

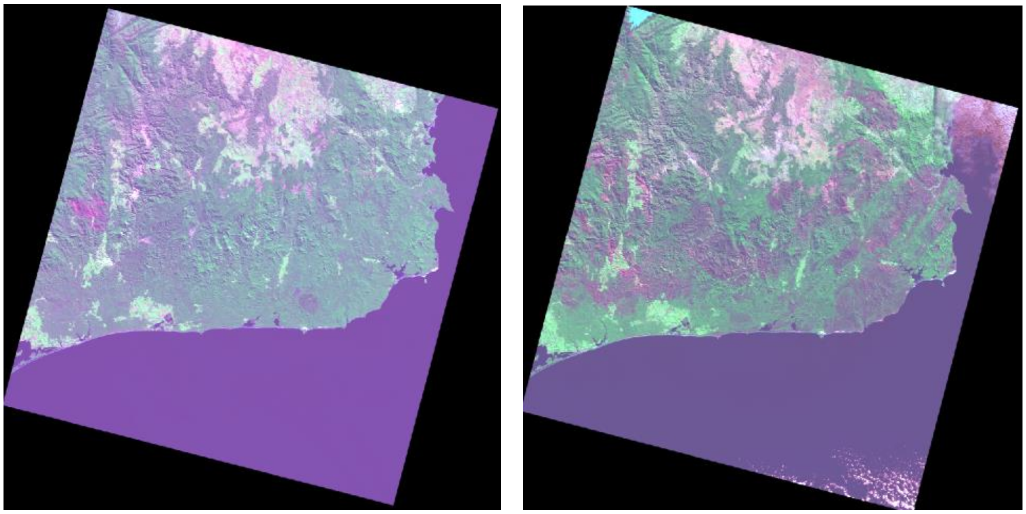

Figure 1: Satellite images showing the study area (before and after the Australian Bushfires)

DATA:

The Landsat 8/9 images are collected from the Earth Explorer - United States Geological Survey. Two satellite images were taken to process the project. First image was captured on 21st May 2019, that is before the bushfires had happened. The second image was captured on 8th June 2020, that is after the bushfires happened. The images include blue band (layer 2), Green band (layer 3), Red band (layer 4), Near Infra-Red/NIR band (layer 5), Short Wave Infra-Red band/ SWIR 1 (layer 6), SWIR 2 (layer 7).

Figure 2: Image showing the Landsat 8/9 Bands

METHODOLOGY:

During pre-processing of the data, the two images were layer stacked in ERDAS IMAGINE in the beginning to make the images color composite and two new subsets were created to cover the area of interest. Object Based Image Analysis technique is being used for classification of the land cover before and after the bush fires. The object-based image grouping the similar pixels was created using segmentation.

SEGMENTATION:

For both the images Multi-Resolution Segmentation was performed through which the images were segmented by similar input values or pixels. The scale parameter is taken 160 and default parameter for the other settings.

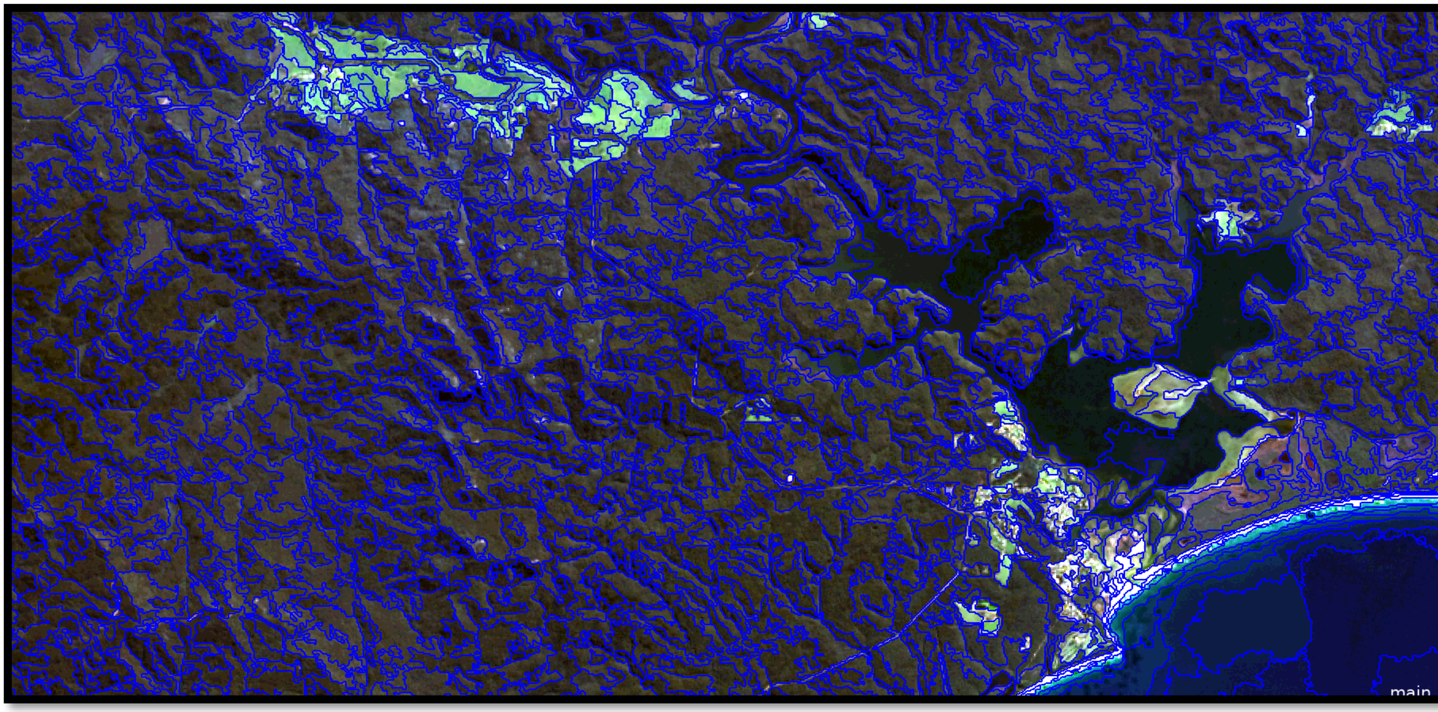

Figure 3: Multi-Resolution Segmentation of the land cover - before the fires happened

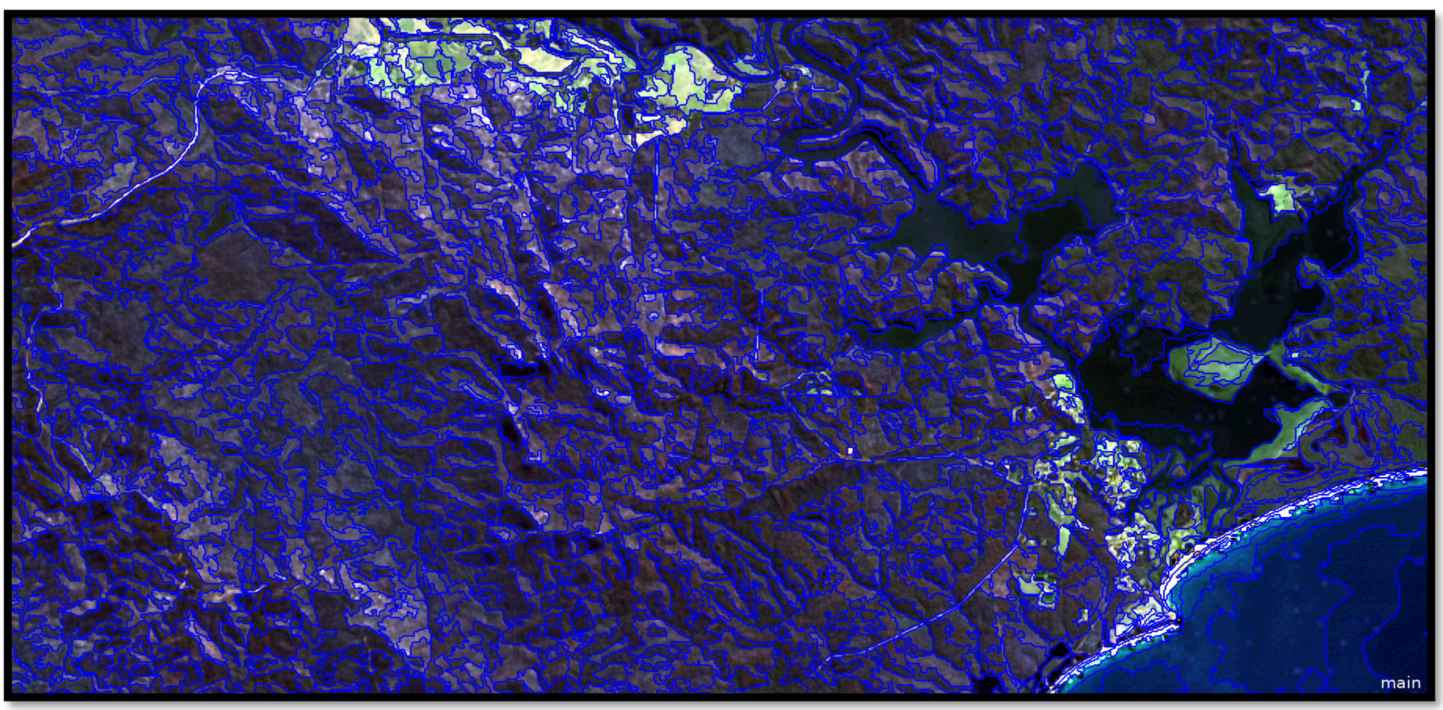

Figure 4: Multi-Resolution Segmentation of the land cover - after the fires happened

CUSTOMISED FEATURES:

The method customized features is followed after the literature "*Burned Area Mapping in Greece Using SPOT-4 HRVIR Images and Object-Based Image Analysis"* (Anastasia Polychronaki, Ioannis Z. Gitas; 2012). The literature clearly depicts the NBR ratio. Besides NBR, NDVI was also performed for pre-fire and post-fire images to study the healthy vegetation.

CUSTOMISED FEATURE 1 (VEGETATION):

NDVI stands for the Normalized Difference Vegetation Index. This feature was performed to check the quality of the vegetation greenness and understanding vegetation density. This was performed using the simple ratio between Near Infra-Red band and Red band with the following equation.

$$NDVI = \frac{(NIR\ - RED)}{(NIR + RED)}$$

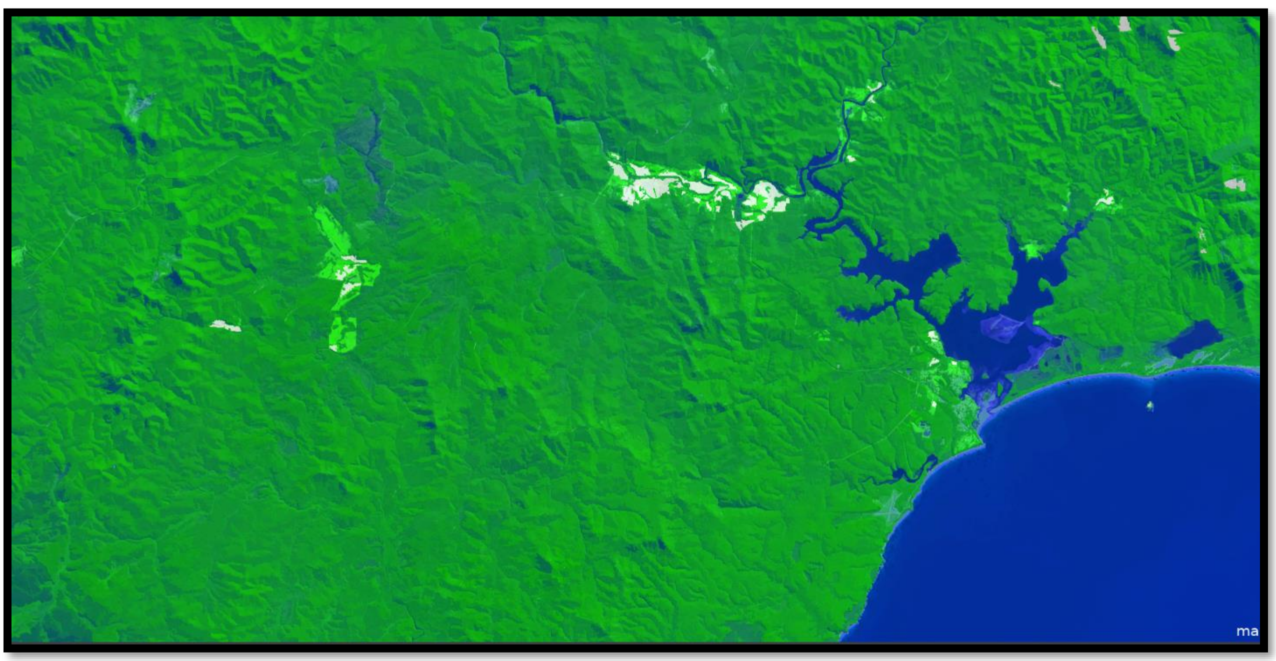

Figure 5: NDVI results of Vegetation for before fires happened

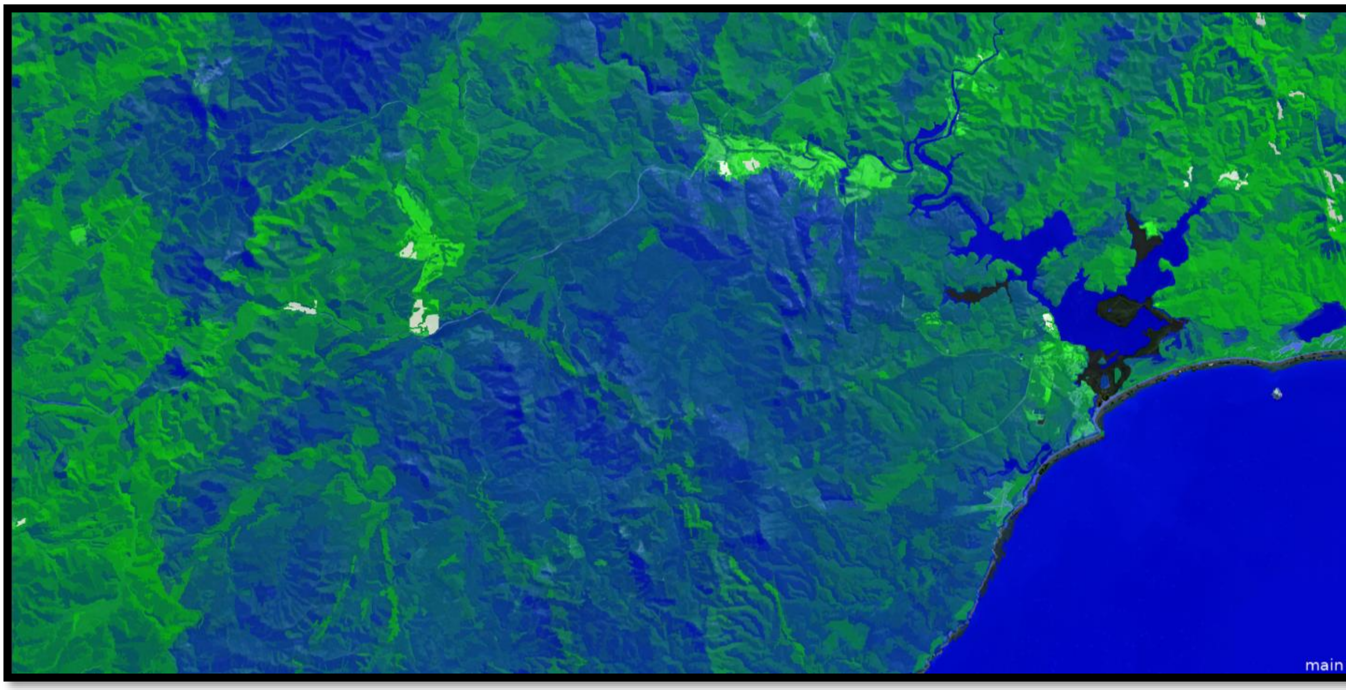

Figure 6: NDVI results of Vegetation for after fires happened

CUSTOMISED FEATURE 2 (BURNED AREA):

Normalized Burn Ratio (NBR) was performed for detecting the burned areas and assessing fire severity to quantify the extent of vegetation loss. It quantifies the difference in Near Infra-Red (NIR) and Short-Wave Infra-Red (SWIR) reflectance.

The sum can be calculated by the following equation. Burned areas were considered as the areas with pixel values less than zero or negative and Non-burned areas were considered as the areas with pixel values above zero or positive.

$$NBR = \frac{(NIR - SWIR)}{(NIR + SWIR)}$$

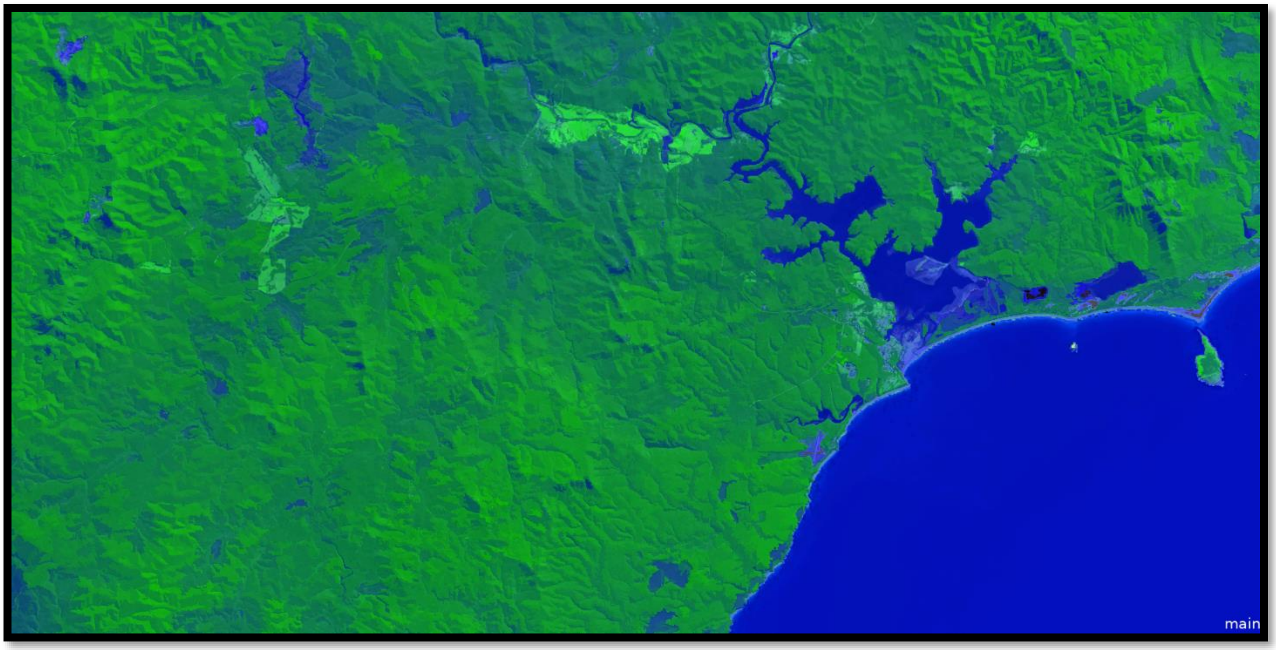

Figure 7: NBR results of burned area for before fires happened

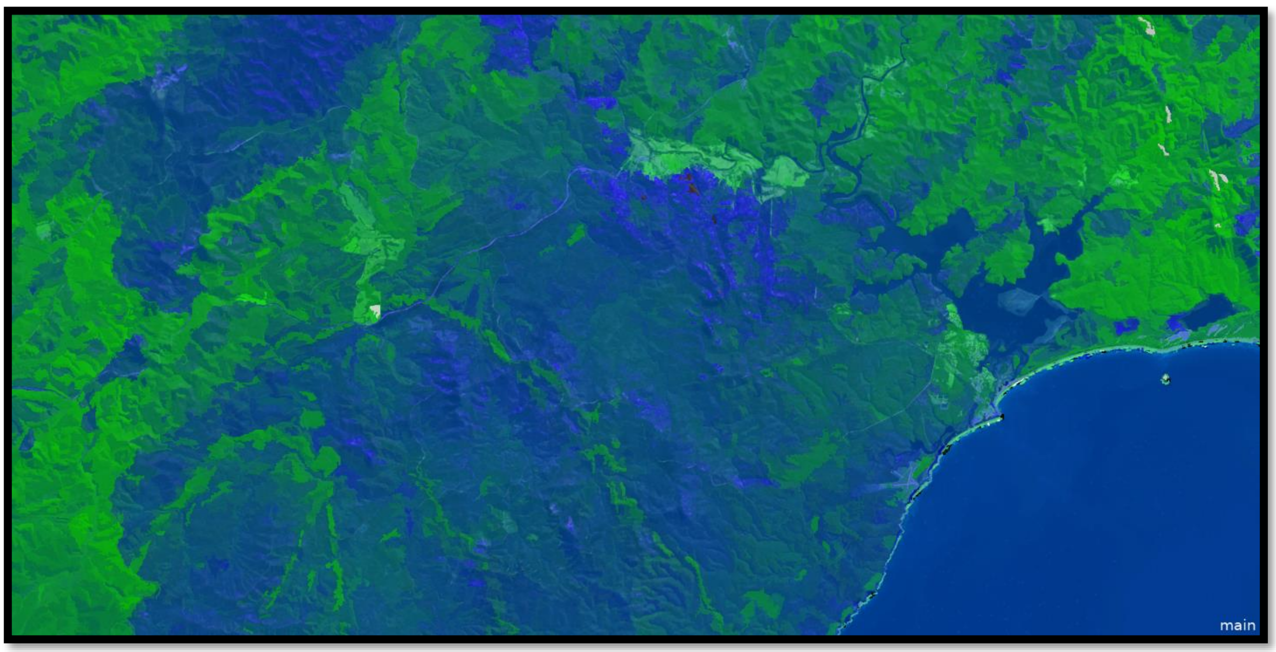

Figure 8: NBR results of burned area for after fires happened

CLASSIFICATION:

The classification of vegetation, water and burned areas using eCognition and its algorithms based on their spectral, textural and contextual characteristics. Assign class algorithm was was used for all these classifications.

PARAMETER	**VALUE**		
	BURNED AREA	**WATER**	**VEGETATION**
CLASS FILTER	Unclassified	Burned areas	Unclassified
CONDITION	NBR < 0.08	Mean NIR < 7500	NDVI > 0.15

CLASSIFICATION OF		
BURNED AREA	WATER	VEGETATION
		

RESULTS:

The results of the classification features demonstrate a good level of accuracy and reliability. The classification accurately assigns specific land cover classes to the segmented objects, providing valuable insights into the composition and distribution of different land cover types within the study area. The NDVI and NBR results are mostly similar.

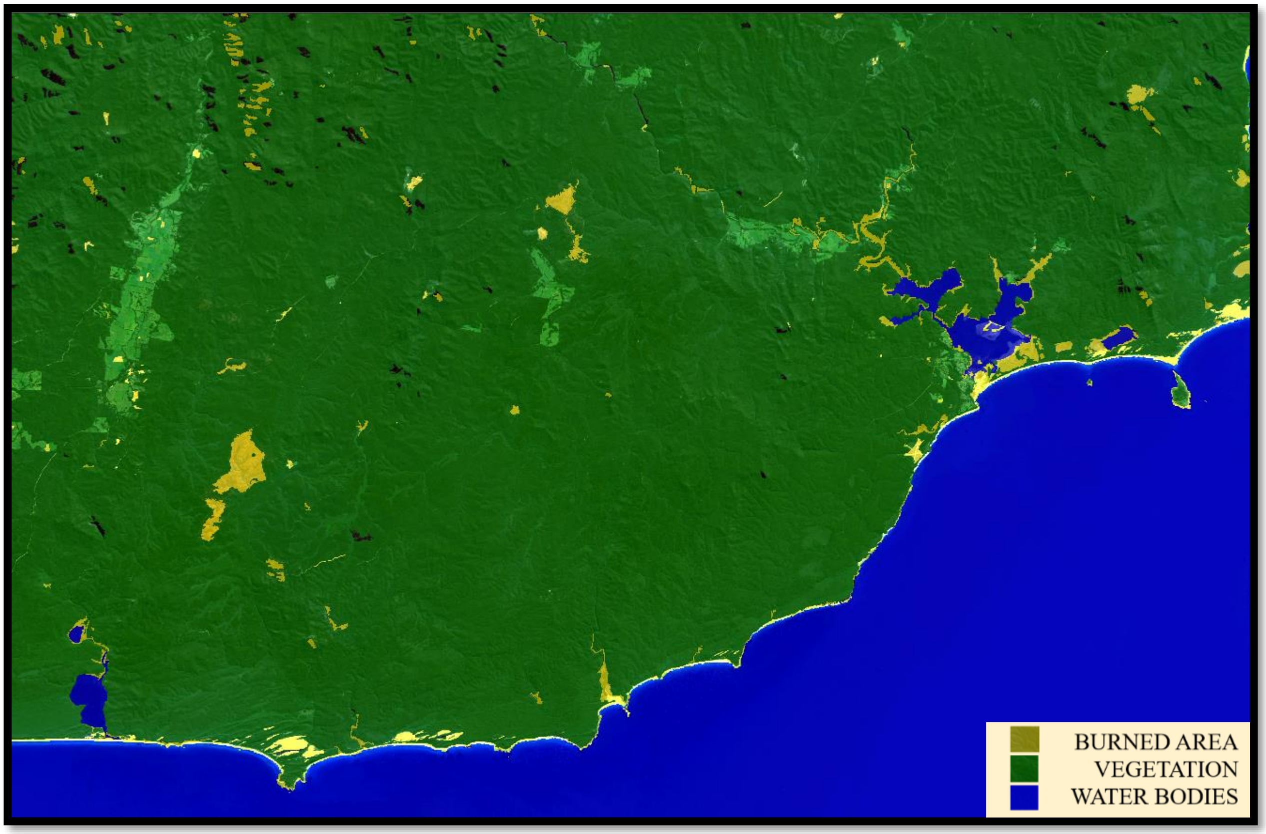

Figure 9: Final classification of the land cover before the Australian Bushfires

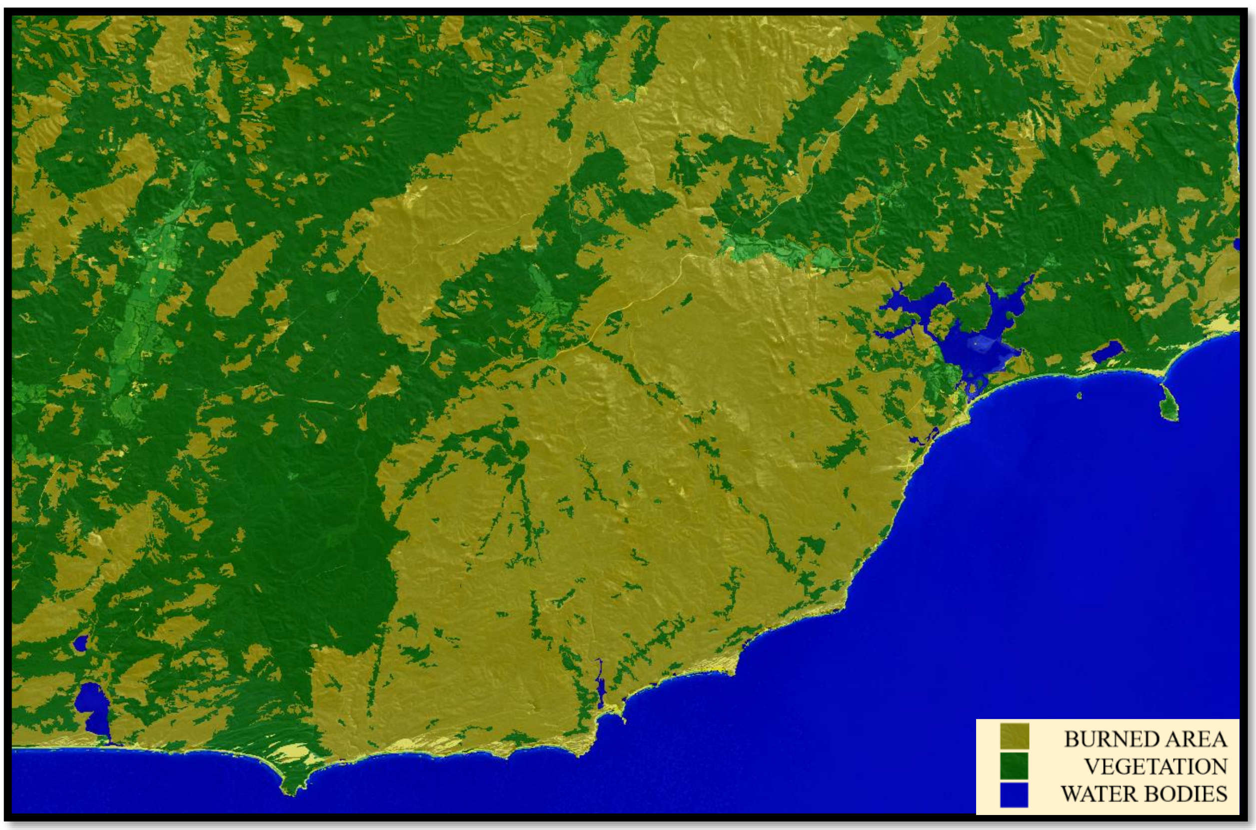

Figure 10: Final classification of the land cover after the Australian Bushfires

Most of the vegetation and burned areas got classified affectively. Though the agricultural lands ware not separatly classified, it still shows as classified light green patches in the image.

There were some areas where the pixcels were not classified or misclassified. This may be due to the shadow areas which are difficult to classify, spectral variability, overlapping spectral signatures, mixed pixcels or segmentation errors.

DISCUSSION:

eCgonition was able to successfully illustrate the impact of the bushfires. Classification of landcover proved substantially robust with near-perfect pixel classes representing real world landcover. Two fundamental indices (NDVI & NBR) provided a stepping-stone for distinguishing bewteen vegetation and burned areas. This was more than adequate enough that no further land cover classification techniques needed to be implemented.

Because of the similarities in pixel value between land cover and water set by the burned areas conditional ($NBR < 0.08$), an additional conditional was set to further classifiy pixels as water ($NIR < 7500$). Ultimately, after all three conditinals were executed, there still existed some unclassified pixels. This may be due to shadows, spectrally similarites, and data issues and should be the focus of further research.

CONCLUSION

This research provides valuable insights into the effectiveness of eCognition as a tool for land cover classification in fire-affected areas. Understanding its capabilities and limitations in accurately capturing the post-fire landscape changes will contribute to the advancement of remote sensing techniques and support future fire monitoring and management initiatives.

The outcomes of this study have significant implications for environmental planning, conservation, and ecosystem management in the Australian bushlands. By comprehensively mapping the pre- and post-fire land cover classification, we can inform policymakers, land managers, and conservationists in making informed decisions to restore and preserve the ecological integrity and resilience of these crucial ecosystems.

In conclusion, the land cover classification analysis of the Australian bushlands before and after the September 2019 - March 2020 bushfires using the eCognition tool holds immense potential in understanding the extent of ecological transformations caused by these devastating fires. Through this research, utilized advanced remote sensing techniques to provide valuable insights into the changes in vegetation, land use, and overall landscape composition. By doing so, we hope to contribute to the collective efforts in restoring and conserving the unique biodiversity and ecological functionality of the fire-affected Australian bushlands.

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