

Storm Surge on a Coral Atoll: The Case of Fongafale Islet in Tuvalu

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Photograph courtesy of Seelan 2015
using an iPhone6

Fongafale

Built Structure →

Ship ↓

← Cumulus

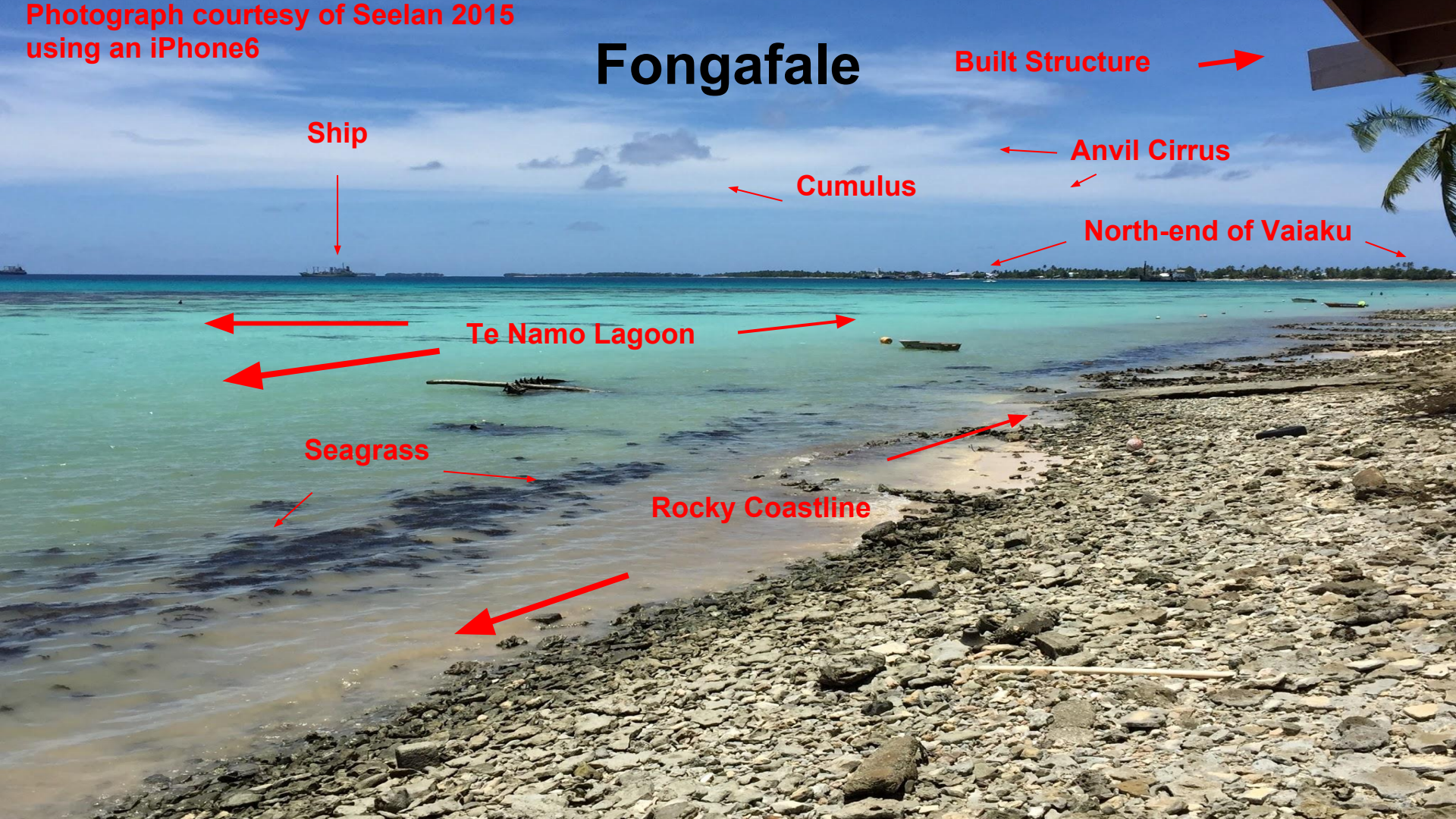
← Anvil Cirrus ↓

← North-end of Vaiaku →

← Te Namu Lagoon →

← Seagrass →

← Rocky Coastline →



Methods — Key Problem

Abstract

1. Introduction

2. Methods

a) Elevation

b) Land Cover

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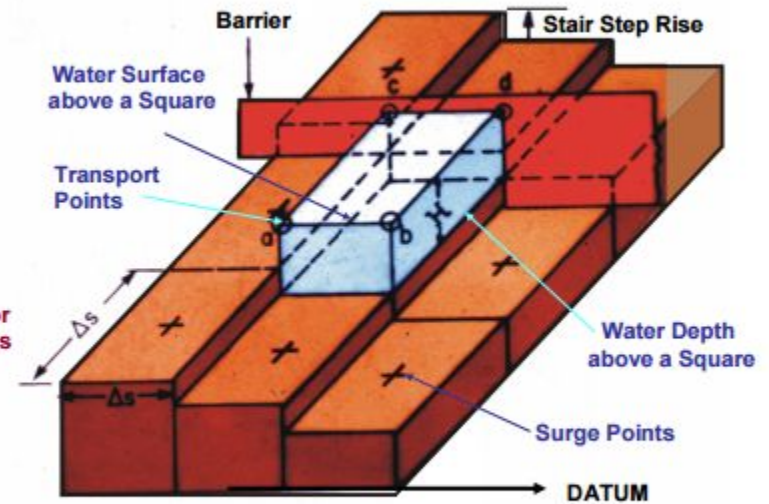
Bibliography

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Sub-grid elements:

- 1 dimensional flow for rivers and streams
- Barriers
- Cuts between barriers
- Channel flow with chokes and expansions
- Increased friction for trees and mangroves

Individual Grid



Elevation

Google's EGM96 Geoid developed for NASA

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Google Earth 2014; Lemoine et al. (1998)

Elevation

Extracted elevation data from KML for ArcGIS using TCX Converter

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TCX Converter
File Help TCX Converter Version 2.0.32 Build Date: 2014-11-06 11:54:14

File Import Garmin Comm GpsBabel Comm File Data

contours_fongafale.kml contours_fongaf

Allow a Waypoint position Error of (m): 6

Nr.	Course Name	Distance	Time Sec.
1	contours_fongaf	79.18385	19004.00

Average Speed
Average Speed: 15.0 Km/h

Course Date:

TIME	LAT	LONG	ALT	DIST	HR BPM	CAD	AVG
SubTrack 0							15.0001
2007-05-09T06:00:00Z	-8.540968	179.171329	0	0	0	0	
2007-05-09T06:00:14Z	-8.541100	179.171832	0	0.0573433	0	0	
2007-05-09T06:01:08Z	-8.541669	179.173796	0	0.2827636	0	0	
2007-05-09T06:01:27Z	-8.540951	179.173694	0	0.3633865	0	0	
2007-05-09T06:01:33Z	-8.540758	179.173583	0	0.388032	0	0	
2007-05-09T06:01:36Z	-8.540662	179.173521	0	0.4006669	0	0	
2007-05-09T06:01:45Z	-8.540523	179.173210	0	0.4381978	0	0	

Course Waypoint:

NAME	DISTANCE	TIME	LAT	LONG	TYPE
------	----------	------	-----	------	------

Export Waypoint Preview Track Modify Settings

Update Altitude Rem Duplicate Pts Invert Track

Fix Bad TCX Joint trk/wpt Mod trk name

Limit Trackpoints Mod time Gap

Change Avg speed (Km/h): 0.00 Apply

Change Avg speed by % increment: 10.00 Increment Decrement

SubTrack: SubTrack 0

Information: Max Altitude: 0 m Tot Ascending Altitude +0 m / 0 m Progress

Google Earth 2014; Lemoine et al. (1998)

Elevation

Mapped elevation points in ArcGIS

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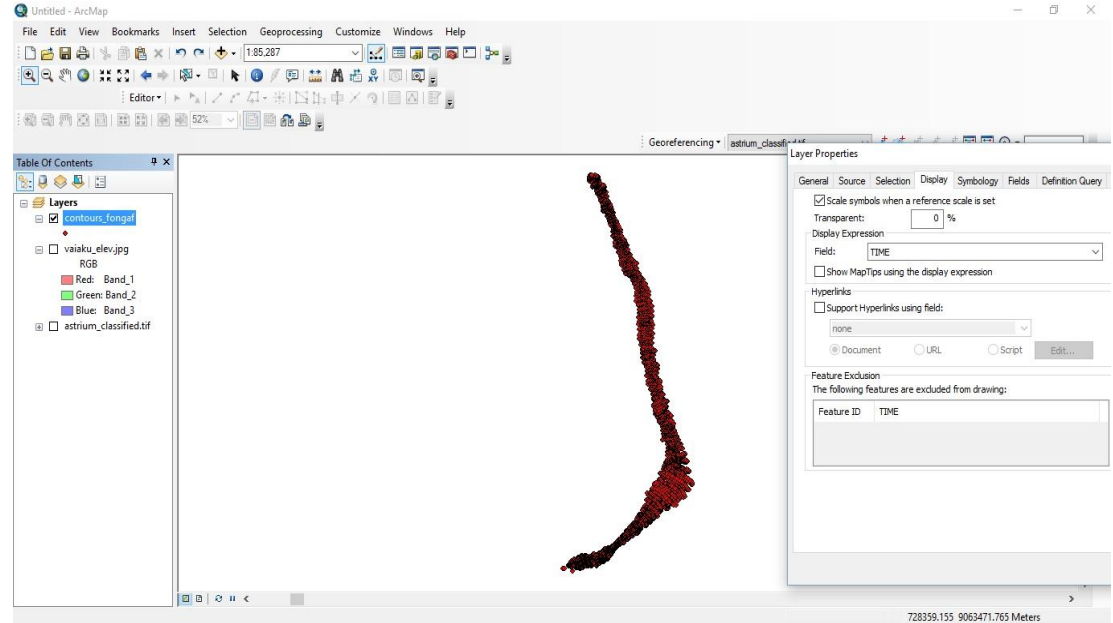
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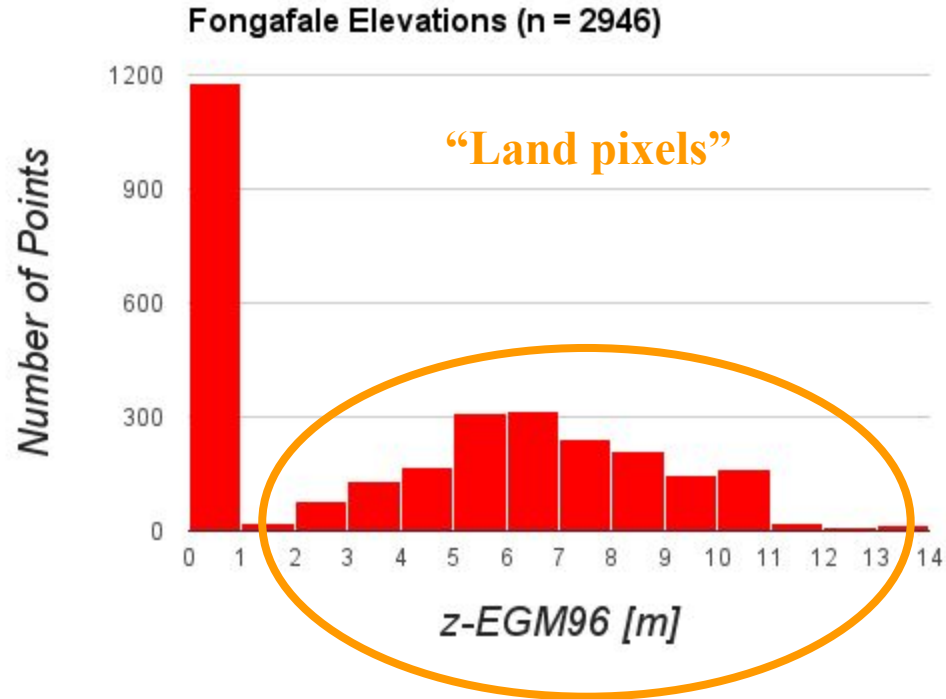
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Google 2014; Lemoine et al. (1998)

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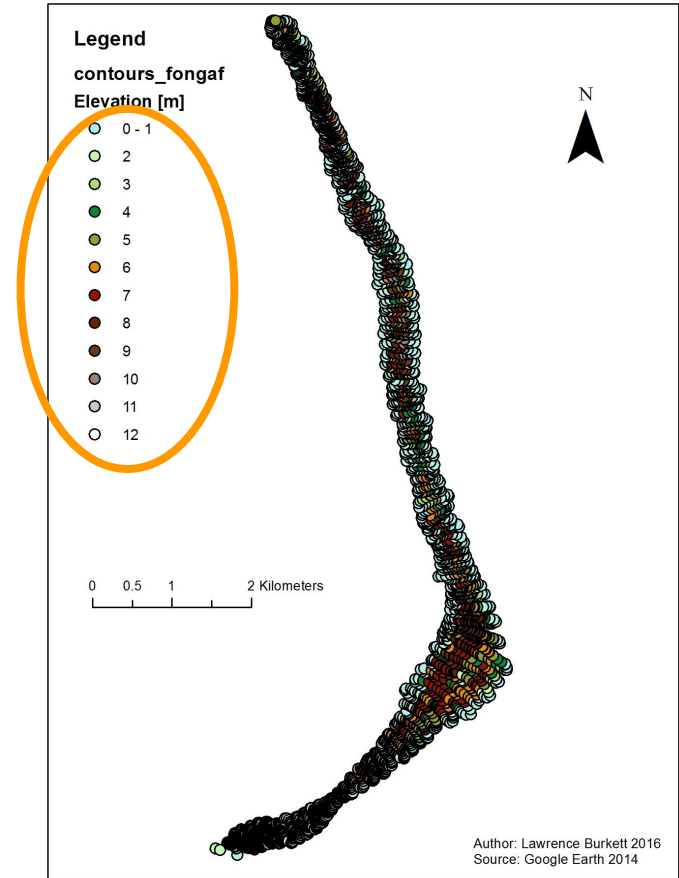
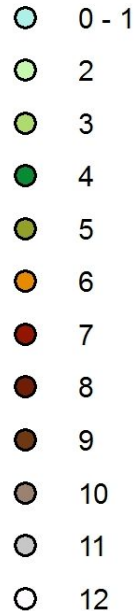
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Elevations seem too high!

Elevation [m]



Elevation

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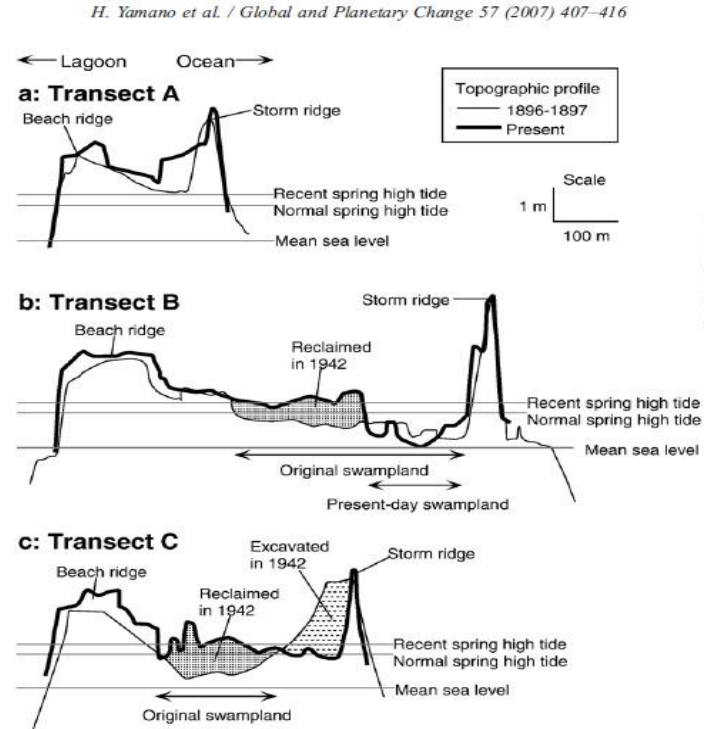
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Compared with transects from a prior survey in 2004 that used a two frequency GPS base station and a one frequency GPS device



Yamano et al. (2007)

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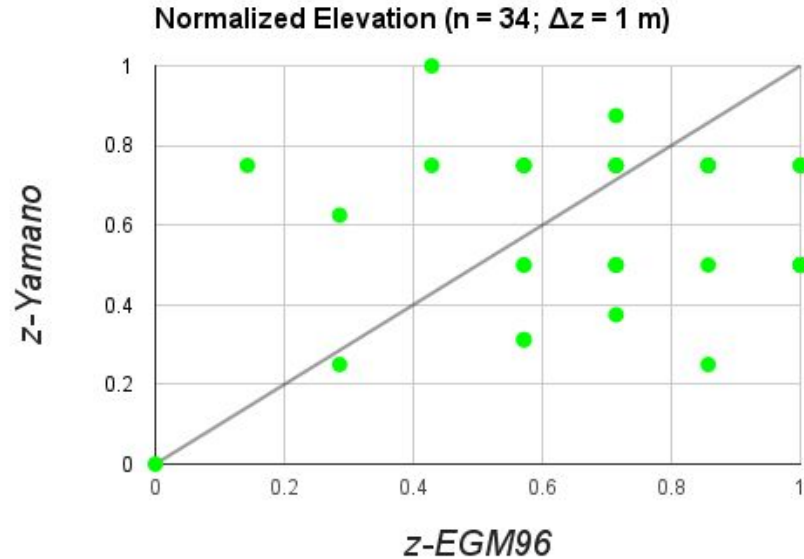
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$$R^2 = +0.17$$



Google Earth 2014; Lemoine et al. (1998); Yamano et al. (2007)

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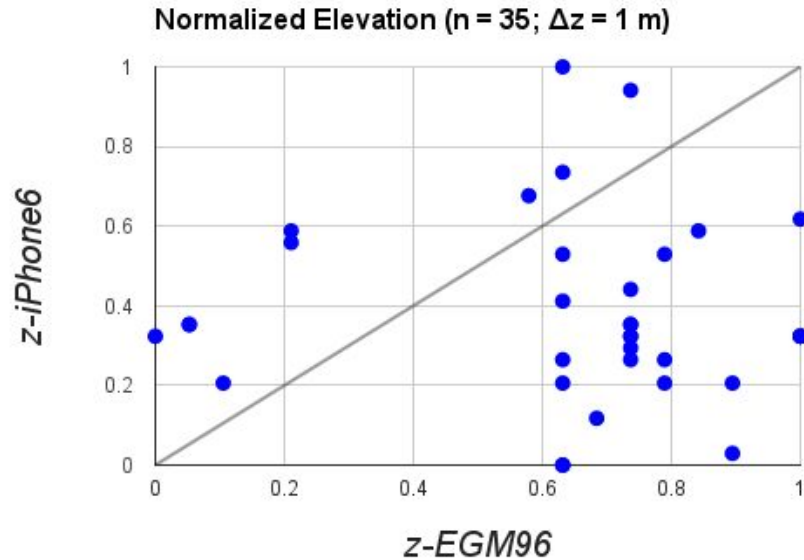
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$$R^2 = -0.05$$

iPhone6 reports elevation but this is from a pressure sensor



Google Earth 2014; Lemoine et al. (1998); iPhone6 2015

Elevation

Attempting to correct elevations using altimetry

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Ideally, an “away
team” should be sent to
GPS elevations — *goal!*

	A	B	C	D	E	F	G	H	I	J
1	img	day	t (UTC)	lat (deg)	lon (deg)	z [m]	sea-level [m]	T [C]	p [mb]	
18										
		10/18/2015	21:28	-8.49105	179.070161	12.25190011	2.302	30.3	1013.7	
19										
		10/18/2015	21:48	-8.491047	179.050847	7.872570404	2.124	29.4	1013.2	

iPhone6 2015; Bureau of Meteorology (Australia) 2015

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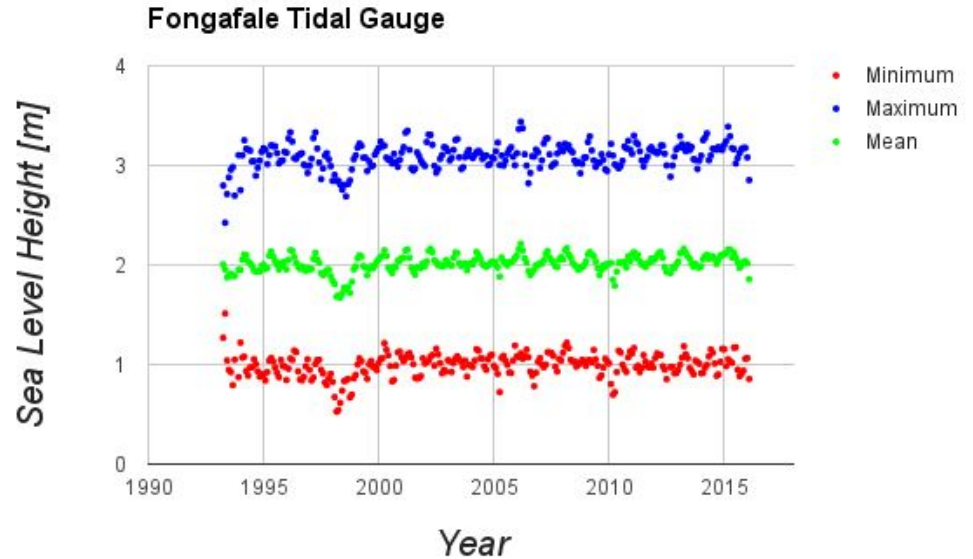
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Ultimately, tidal data mined will be “added” to storm surge



Bureau of Meteorology (Australia) 2016

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**Manually digitized polygons around buildings
and the runway — infrastructure!**



Google Earth 2014

Land Cover

Used ERDAS Imagine to do
image classification

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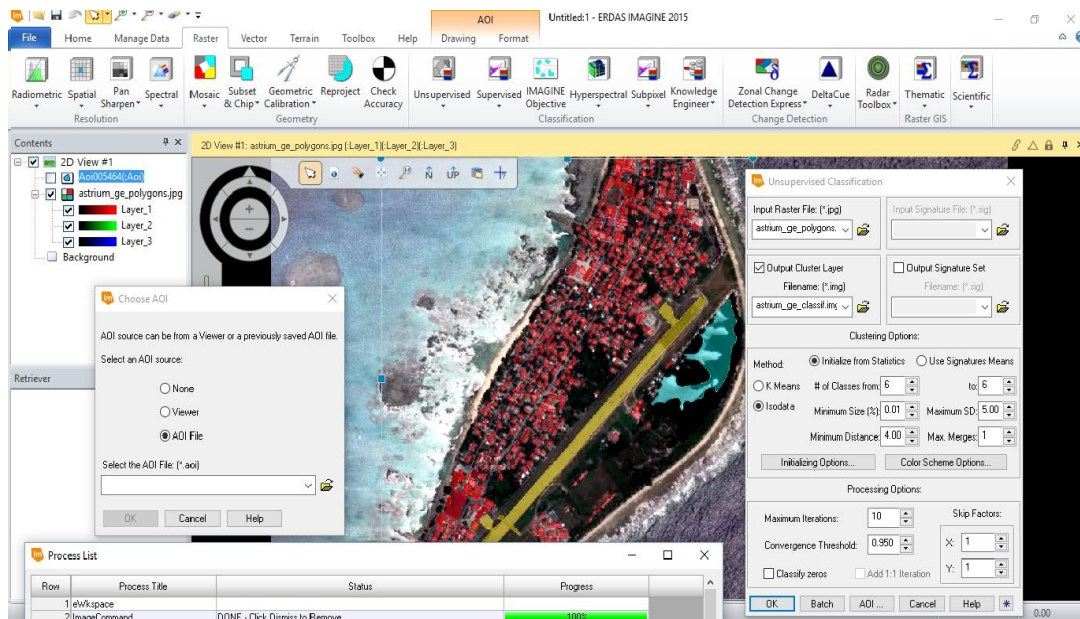
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Google Earth 2014

Land Cover

Ran an unsupervised isodata classification algorithm for remaining pixels

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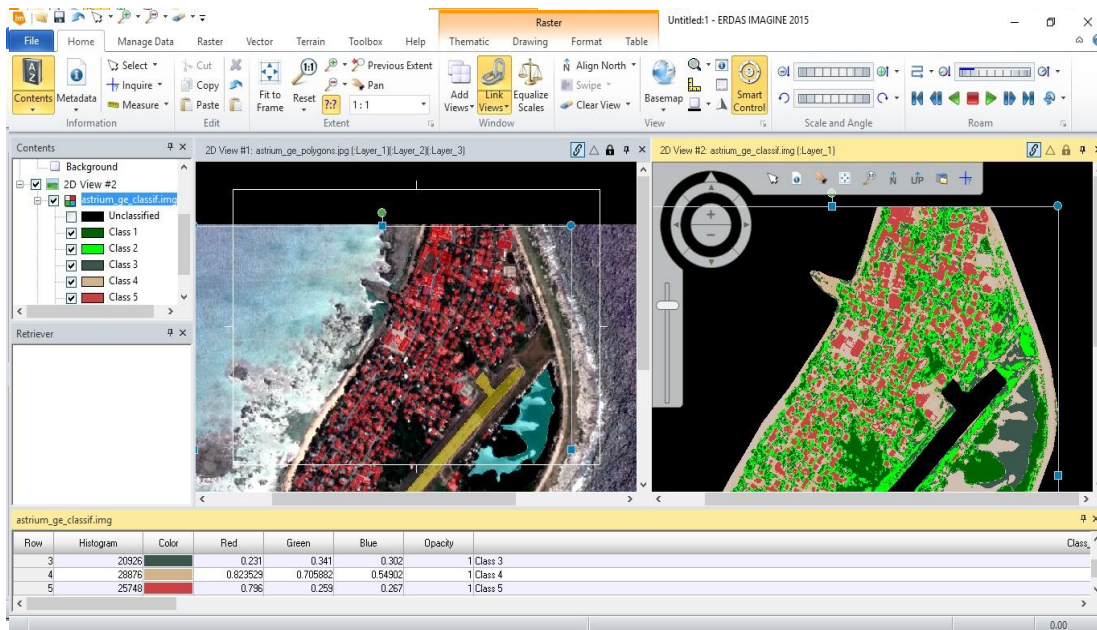
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Google Earth 2014

Land Cover

Preliminary result — features ... need characterized
in terms of importance and roughness

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Google Earth 2014

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“Abbreviated” listing

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Bibliography

I. Literature

II. Software

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- I. Literature
- II. Software**

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Google Docs / Google Sheets / Google Slides, Google. Mountain View, California. <https://www.google.com/docs/about/>

TCX Converter, http://www.tcxconverter.com/TCX_Converter/TCX_Converter_ENG.html

Questions

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