EUROPEAN COMMISSION
JOINT RESEARCH CENTRE
Institute for the Protection and Security of the Citizen
Global Security and Crisis Management Unit
CriTech

Wednesday, 30 November 2011

Typhoon Trina (Simulation)

Samoa, 29 November to 2 December 2011

Executive Summary

For a simulation exercise of the Samoan authorities, JRC modelled the storm surge associated to a fictive typhoon. Typhoon Trina is forecast to hit the Samoa Islands on 30 November 2011, causing storm surge up to 1.8m.

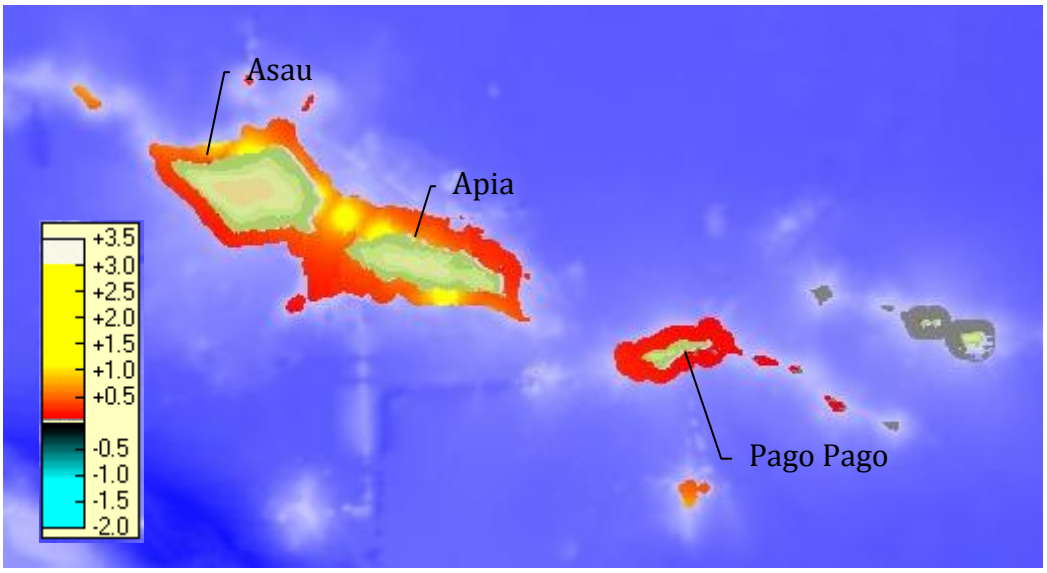


Figure 1. Predicted maximum storm surge for Trina (detailed view).

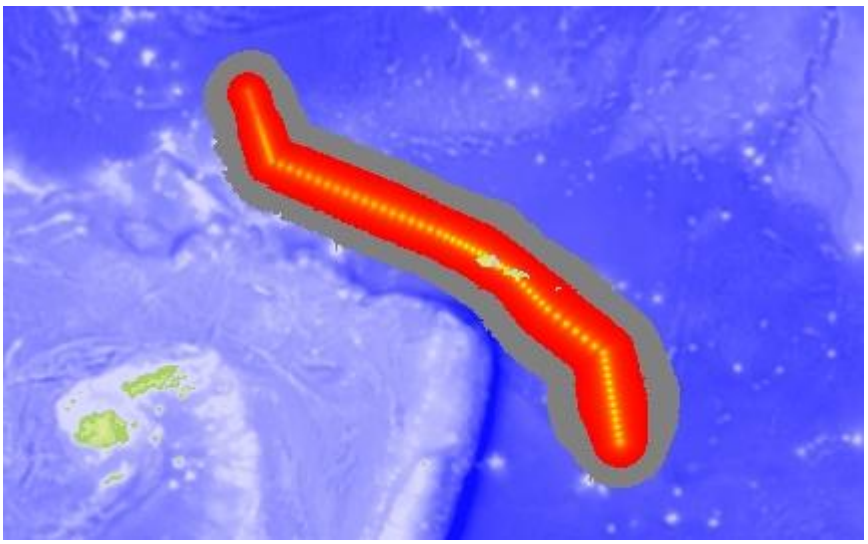


Figure 2. Predicted maximum storm surge (full view).

Background

From 30 November to 3 December, the Samoan authorities are holding an exercise to test emergency response capabilities and preparedness. The exercise consists of a table top exercise with the Disaster Advisory Council (a run through of Ministry level responses to the simulation), followed by an online exercise using various technologies and systems.

JRC was invited to participate with the Global Disaster Alert and Coordination System (GDACS). GDACS provides monitoring on natural disasters worldwide and humanitarian impact analysis. Impact is assessed using physical and risk models, and alerts are sent to over 15000 professional users in case of disasters potentially requiring international intervention.

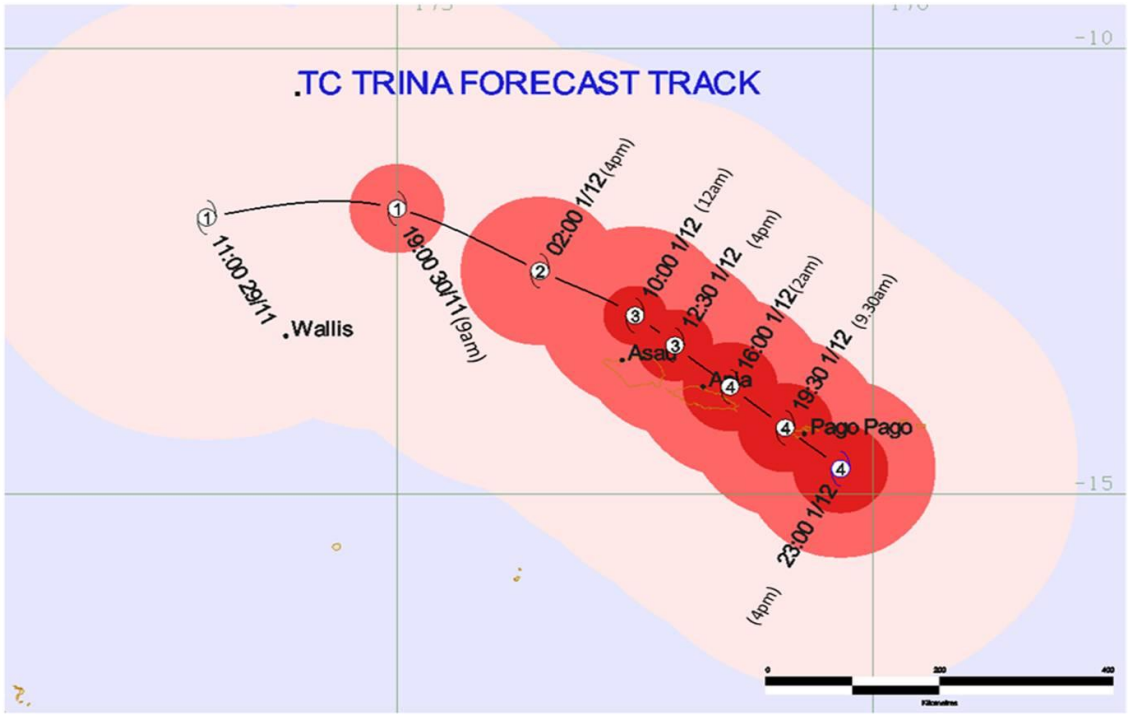
For tropical cyclones, GDACS usually relies on cyclone advisories parsed, compiled and disseminated in OGC format by the Pacific Disaster Centre. From this track data, JRC then calculates wind fields and storm surge. These, along with areas of extreme rainfall detected from satellites, are then overlaid with population and infrastructure databases to provide an impact assessment.

For this simulation, JRC decided to limit its contribution to the storm surge. Using track information provided by the Samoa MET office, JRC established a set of realistic (although worst-case) physical parameters for input in the storm surge model. With these, the HyFlux2 shallow-water hydrodynamic model was used to calculate the storm surge, with exactly the same code and procedures that are used for real cyclones. Simulation runs typically take about 20 minutes to run, and produce output in many standard formats for further use and integration in maps and systems used by emergency management authorities.

Storm surge scenario and model

Scenario

The scenario used by JRC is based on a track provided by the MET office. The track was then shifted south by 0.6 decimal degrees in order to force the storm surge to hit the islands. (With the original track, the maximum storm surge would have been about 60km north of the islands).



The data was used to determine physical parameters needed to recalculate the wind field. Typically, we use the radii at which wind speeds are respectively 34, 50 or 64 knots, since these values are given in cyclone advisories. Based on historical typhoons, we selected average radii values, which we applied uniformly to all quadrants around the storm eye.

Note that we increased the wind speed significantly, up to category V, in order to create a worst case scenario.

UTC Time	*time*	*lat*	*long*	*Vmax (m/s)*	*Wind radii at 64 knots (nm)*	*Wind radii at 50 knots (nm)*	*Wind radii at 34 knots (nm)*
11/29/2011 0:00	0	-9.3	-178.4	48	23.1	48.8	95.5
11/29/2011 6:00	6	-9.9	-178.2	51	24	50.5	97.7
11/29/2011 12:00	12	-10.5	-178	64	35	65	119
11/29/2011 18:00	18	-11.1	-177.8	67	40	70	130
11/30/2011 0:00	24	-11.7	-176.4	69	44	74	133
11/30/2011 6:00	30	-12.3	-175	71	46	72	128
11/30/2011 12:00	36	-12.9	-173.6	74	46	76	134
11/30/2011 18:00	42	-13.4	-172.6	77	46	77	137
12/1/2011 0:00	48	-13.9	-171.8	79	44	78	146
12/1/2011 6:00	54	-14.8	-170.9	77	46	77	137
12/1/2011 12:00	60	-15.9	-169.5	74	46	76	134
12/1/2011 18:00	66	-17	-169.3	74	46	76	134
12/2/2011 0:00	72	-18.1	-169.1	71	46	72	128
12/2/2011 6:00	78	-19.2	-168.9	64	35	65	119
12/2/2011 12:00	84	-20.3	-168.8	64	35	65	119
12/2/2011 18:00	90	-21.4	-168.7	64	35	65	119
12/3/2011 0:00	96	-22.5	-168.6	64	35	65	119

Model

JRC developed a hydrodynamic model solving the shallow-water equations by a finite volume code called HyFlux2, which have been largely used in GDACS for Tsunami run up inundation modelling (*G. Franchello, 2010*). As atmospheric forcing, the model is taking into account the pressure gradient and wind friction. Some physical effects, like astronomical tide, radiation stress, precipitation are not yet implemented. The model performs the simulations using a nested approach: a first coarse simulation is done with a regular, Cartesian grid size of 3 min (about 5400m) and then for the inundation a finer simulation is performed with a grid size of 0.5 min (about 900m). Having detailed bathymetry (90 m grid size), a more fine simulation could describe with more details the inundated area.

The models have been tested mostly in areas of shallow water, like the Caribbean and the Philippines. Application of the model in deeper water areas has not been validated by JRC, but

radiation stress might have a larger influence in steeper conditions (Graber *et al.*, 2006) like in the Samoa Island.

Results

Impact

The storm surge would be highest in Leagiaga and Sasina, with 1.8m. Other affected places are listed below. A full list of affected places is available online[1].

Table 1. Locations affected by Storm surge (15 of 118). Calculation based on advisory number 1 of 29 Nov 2011

Date	*Name*	*Country*	*Storm surge height (m)*
30 Nov 2011 19:00:00	Leagiaga	Samoa	1.8m
30 Nov 2011 19:00:00	Sasina	Samoa	1.8m
30 Nov 2011 23:00:00	Saleimoa	Samoa	1.6m
01 Dec 2011 01:00:00	Poutasi	Samoa	1.6m
30 Nov 2011 23:00:00	Fasitootai	Samoa	1.5m
30 Nov 2011 21:00:00	Tuasivi	Samoa	1.4m
30 Nov 2011 19:00:00	Fagamalo	Samoa	1.2m

References

Model results can be accessed on the JRC/GDACS website. Note this is a web site in development. The new GDACS website should be launched by the end of December.

- http://new.gdacs.org/cyclones/stormsurge.aspx?eventid=10002
- Interactive dynamic map with animations: http://dma.jrc.it/map/?WGS84=true&image=http://tsunami.jrc.it/cyclonesurge/10002/final/outres1.gif|Maximum%20Storm%20Surge|-184.5%20|-24.5%20|-163.%20|-3.%20||&kml=http://tsunami.jrc.it/cyclonesurge/10002/final/locations.kml|Locations
- KMZ file: http://tsunami.jrc.it/cyclonesurge/10002/final/locations.kmz
- Animation: http://tsunami.jrc.it/cyclonesurge/10002/final/outres1.gif
- Data: http://tsunami.jrc.it/cyclonesurge/10002/final/
- Other information: http://new.gdacs.org/resources.aspx?eventid=10002&episodeid=&eventtype=TC

Simulation scenario:

[1] http://new.gdacs.org/transform.aspx?xmlurl=http://tsunami.jrc.it/cyclonesurge/10002/final/locations.xml&xslurl=XSLT/locations.xslt&pname=mode|eventid&pvalue=list|

- Dedicated Facebook page: http://www.facebook.com/profile.php?id=100003167124850

- Twitter: @ALERTSsp

Scientific references:

- Graber, H., V. Cardone, R. Jensen, D. Slinn, S. Hagen, S. Cox, M. Powell and C. Grassl (2006). Coastal Forecasts and Storm Surge Predictions for Tropical Cyclones. Oceanography, 19(1).

- Franchello, G. (2010). Shoreline tracking and implicit source terms for a well balanced inundation model. International Journal for Numerical Methods in Fluids, 63(10), 1123–1146.