TSUNAMI HAZARD ASSESSMENT ALONG THE COAST OF EASTERN VISAYAS, PHILIPPINES

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1. Earthquake source parameters

Table 1. Earthquake source parameters used for maximum credible scenario (Salcedo, 2010) and model for 2012 event (Heidarzadeh et al., 2014).

Case	Magnitude	Long (°E)	Lat (°N)	Length (km)	Width (km)	Strike (°)	Dip (°)	Rake (°)	Slip (m)	Depth (km)
Maximum credible scenario	7.9	126.60	11.60	143	65.95	165	45	90	1.89	0
Model for the 2012 event	7.6	126.60	10.20	80	40	345	36	90	1.21	46

2. Tide gauge stations

Table 2. Location and water depths of tide gauge stations parallel to the Philippine trench axis.

Station Name	Latitude ($°N$)	Longitude ($°E$)	GEBCO_2014 1-arc min	GEBCO_2014 30-arc sec	GEBCO_08 + Bathymetry points 1-arc min	GEBCO_08 + Bathymetry points 30-arc sec
			Water depth (m)			
Dolores	12.030	125.489	1.0	1.0	1.0	3.0
Taft	11.897	125.422	1.0	1.0	1.0	1.0
Borongan*	11.613	125.447	1.0	1.2	9.8	8.1
Maydolong	11.511	125.495	2.3	1.0	10.8	15.0
Llorente	11.412	125.553	28.6	1.0	43.0	3.6
Hernani	11.323	125.620	30.4	1.0	21.8	1.0
McArthur	11.230	125.538	1.0	1.0	1.0	1.0
Guiuan_01*	11.023	125.627	1.0	2.6	2.9	1.5
Guiuan_02*	10.980	125.812	31.6	1.0	18.5	6.1
Homonhon	10.763	125.712	1.0	1.0	1.0	1.0
Dapa*	09.743	126.055	4.2	2.9	5.4	4.1
Tandag*	09.088	126.197	7.1	1.0	4.8	2.7
Bislig*	08.238	126.432	1.0	1.0	1.0	2.9
Virac*	13.581	124.234	13.5	7.1	1.0	1.0

*Existing tide gauge stations

Table 3. Location and water depths of tide gauge stations in the Leyte Gulf.

Station Name	Latitude ($°N$)	Longitude ($°E$)	GEBCO_2014 1-arc min	GEBCO_2014 30-arc sec	GEBCO_08 + Bathymetry points 1-arc min	GEBCO_08 + Bathymetry points 30-arc sec
			Water depth (m)			
Balangiga	11.097	125.395	11.1	1.0	7.3	1.0
Tacloban*	11.204	125.03	1.2	1.0	3.3	2.8
Dulag	10.953	125.037	2.9	1.0	4.3	3.0
Agbuyog	10.737	125.019	1.0	1.0	4.3	2.0
Silago	10.585	125.187	6.3	1.0	1.0	19.9
Hinundayan	10.352	125.255	1.0	1.0	20.6	1.0

Table 4. Tide gauge station that recorded the small tsunami generated by M7.6 earthquake on August 31, 2012.

Station Name	Latitude ($°N$)	Longitude ($°E$)	GEBCO_2014 1-arc min	GEBCO_2014 30-arc sec	GEBCO_08 + Bathymetry points 1-arc min	GEBCO_08 + Bathymetry points 30-arc sec
			Water depth (m)			
Legazpi	13.146	123.763	25.4	4.8	1.0	1.0

Table 5. Summary of water gauges used in the computation of tsunami inundation.

Region	Water Gauges			Municipality/City
	Code	Latitude (°N)	Longitude (°E)	
R4a	WG1	11.609511	125.445708	Borongan City
	WG2	11.503553	125.501677	Maydolong
R4b	WG3	11.412963	125.550118	Llorente
	WG4	11.321714	125.620361	Hernani
R4c	WG5	11.246295	125.543872	Gen. Mc Arhur
	WG6	11.229404	125.590912	Salcedo
R4d	WG7	11.023089	125.723352	Guiuan
	WG8	10.934175	125.825760	

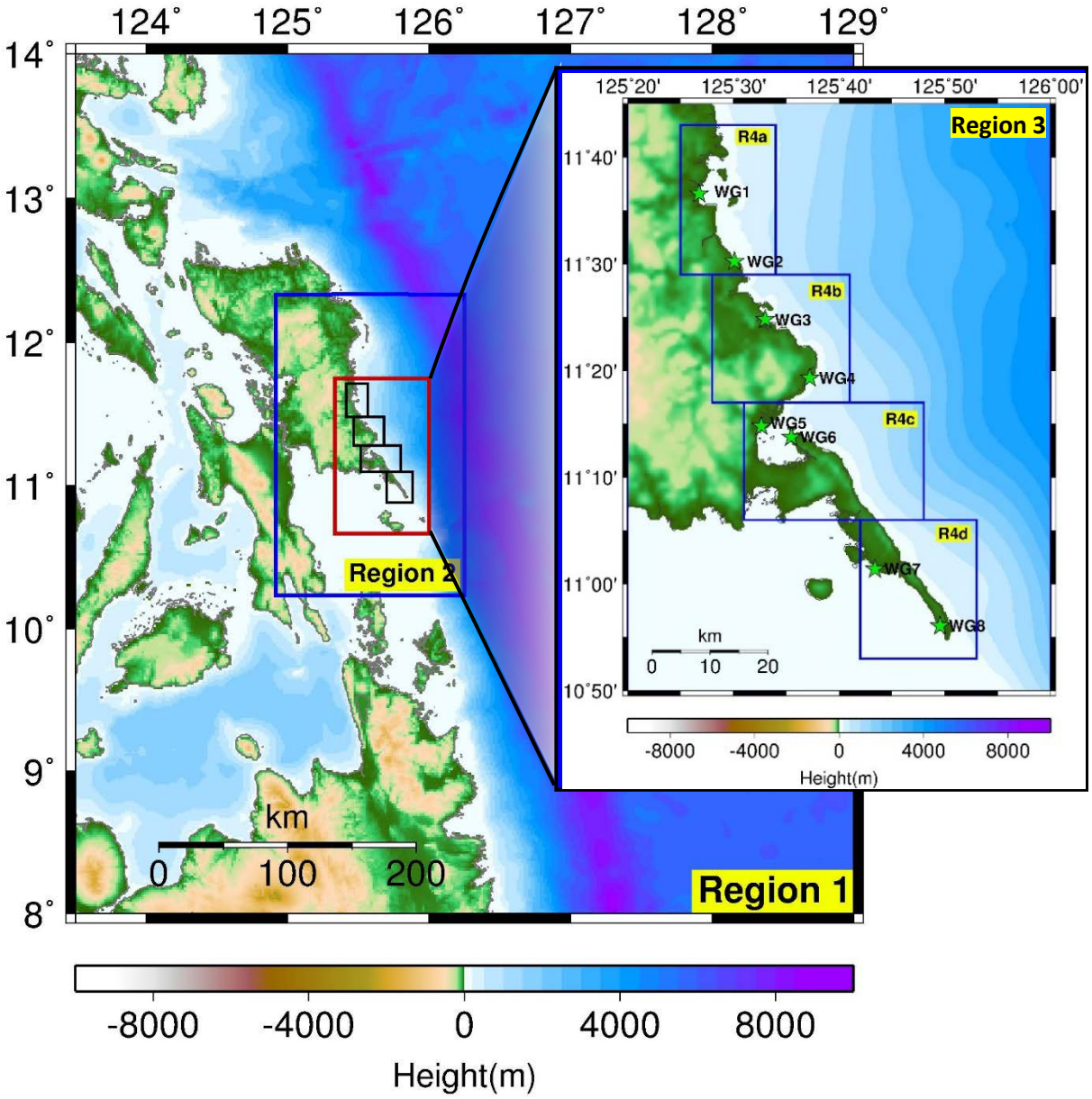

Figure 1. Computational domain for tsunami inundation. Inset map corresponds to the smallest region in the computational domain. Assumed water gauges are represented by star symbol.

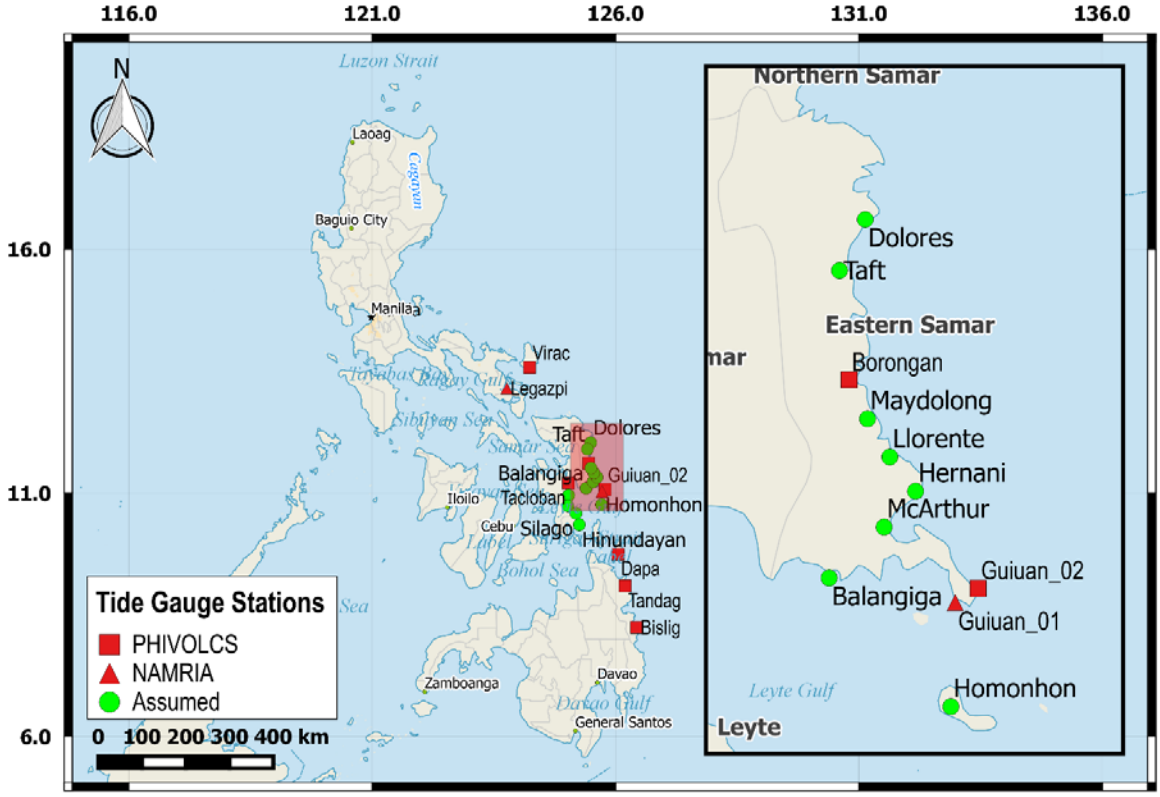

Figure 2. Location of tide gauge stations set as output points.

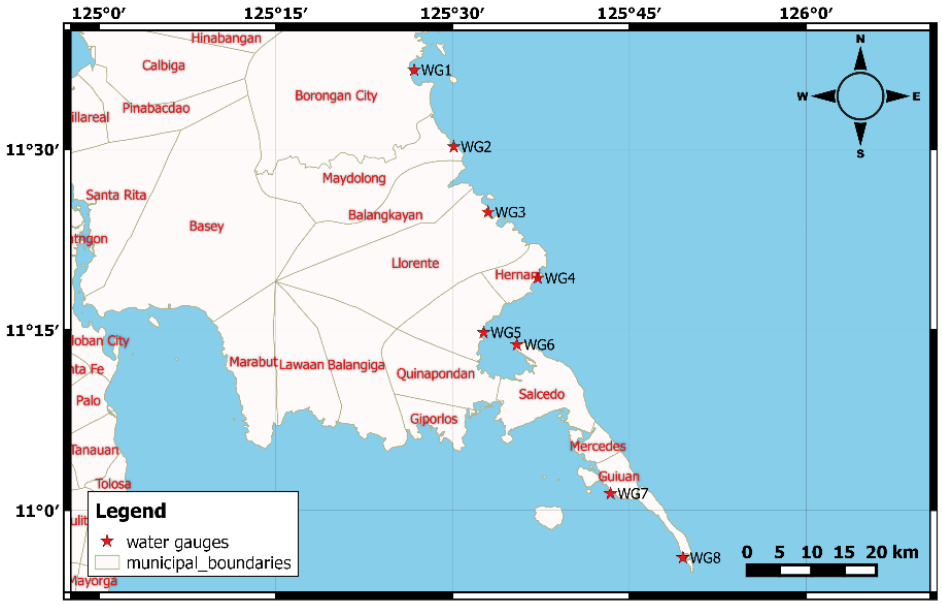

Figure 3. Location of the assumed water gauges (red star) used in tsunami inundation modeling.

3. Results (Tsunami Height)

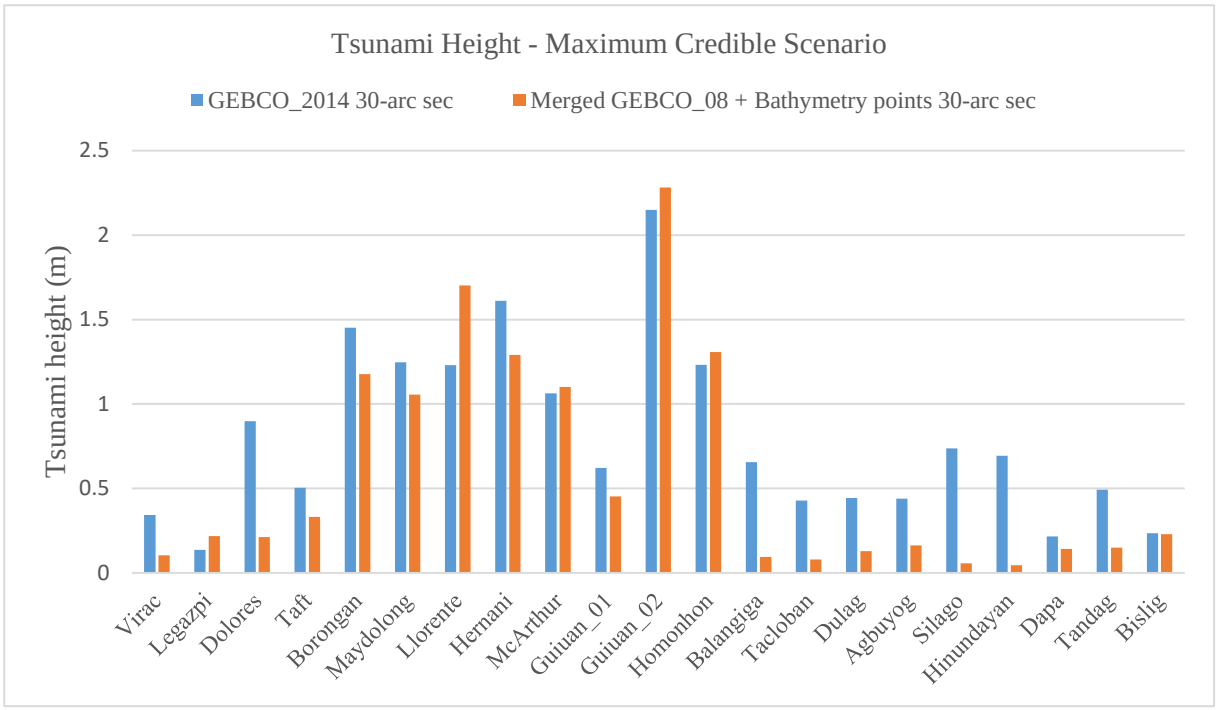

Figure 4. Maximum tsunami height for the maximum credible scenario at all tide gauge stations using different bathymetry data.

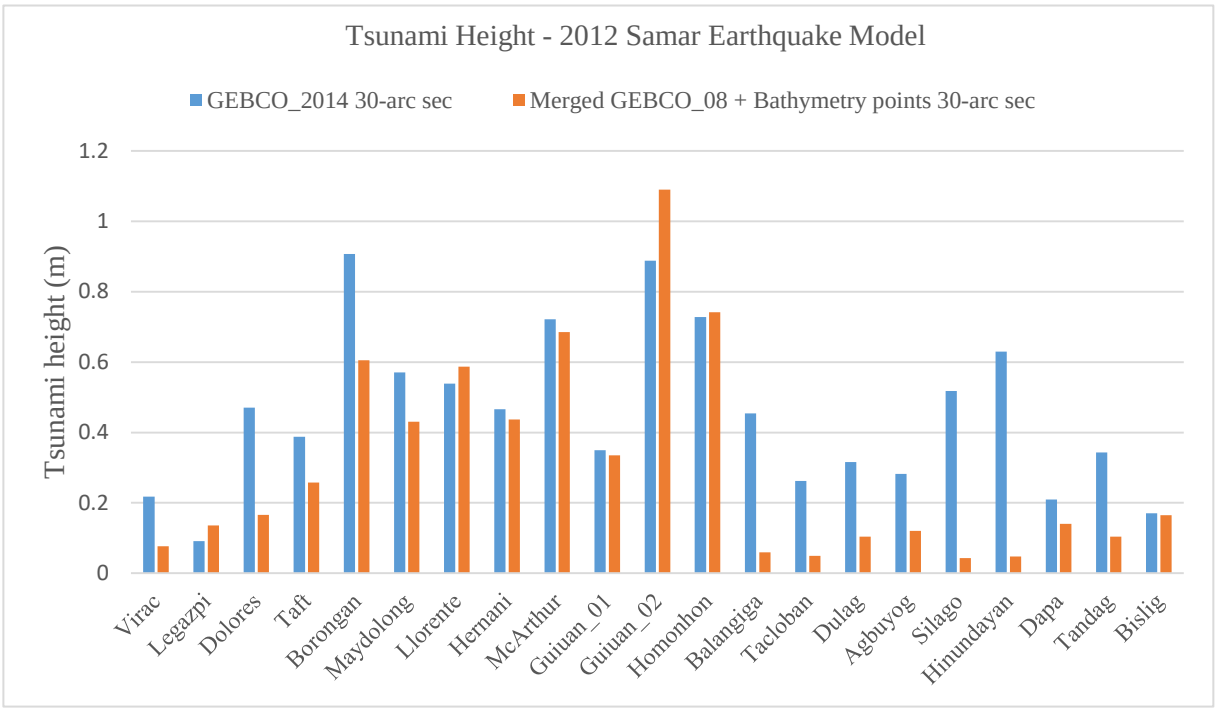

Figure 5. Maximum tsunami height for the 2012 Samar earthquake at all tide gauge stations using different bathymetry data.

Table 6. Tsunami height of the maximum credible scenario using different bathymetry data.

Tide Gauge Stations	GEBCO_2014 1-arc min	GEBCO_2014 30-arc sec	GEBCO_08 + Bathymetry points 1-arc min	GEBCO_08 + Bathymetry points 30-arc sec
Virac*	*0.331*	*0.343*	*0.085*	*0.104*
Legazpi**	0.154	0.136	0.263	0.217
Dolores	0.721	0.898	0.15	0.212
Taft	0.793	0.505	0.294	0.331
Borongan*	1.121	1.452	1.17	1.178
Maydolong	1.608	1.248	1.022	1.056
Llorente	1.023	1.23	0.788	1.703
Hernani	1.712	1.612	1.527	1.29
McArthur	0.846	1.064	0.677	1.102
Guiuan_01**	0.267	0.621	0.217	0.453
Guiuan_02*	2.107	2.149	1.68	2.282
Homonhon	0.811	1.232	0.624	1.308
Balangiga	0.616	0.655	0.089	0.094
Tacloban*	0.257	0.428	0.076	0.08
Dulag	0.368	0.444	0.054	0.128
Agbuyog	0.422	0.44	0.089	0.163
Silago	0.536	0.737	0.043	0.057
Hinundayan	0.327	0.694	0.035	0.046
Dapa*	0.176	0.216	0.23	0.143
Tandag*	0.476	0.493	0.274	0.149
Bislig*	0.19	0.235	0.184	0.23

* - PHIVOLCS stations
** - NAMRIA stations

Table 7. Tsunami height of the 2012 Samar earthquake model using different bathymetry data.

Tide Gauge Stations	GEBCO_2014 1-arc min	GEBCO_2014 30-arc sec	GEBCO_08 + Bathymetry points 1-arc min	GEBCO_08 + Bathymetry points 30-arc sec
Virac*	0.19	0.218	0.054	0.077
Legazpi**	0.1	0.091	0.129	0.136
Dolores	0.556	0.471	0.101	0.166
Taft	0.575	0.388	0.203	0.258
Borongan*	0.577	0.907	0.551	0.605
Maydolong	0.797	0.571	0.628	0.431
Llorente	0.302	0.539	0.304	0.587
Hernani	0.343	0.466	0.328	0.437
McArthur	0.494	0.722	0.368	0.685
Guiuan_01**	0.203	0.35	0.179	0.335
Guiuan_02*	0.582	0.888	0.603	1.09
Homonhon	0.391	0.728	0.383	0.742
Balangiga	0.391	0.454	0.05	0.059
Tacloban*	0.177	0.262	0.04	0.049
Dulag	0.238	0.316	0.04	0.104
Agbuyog	0.26	0.282	0.038	0.12
Silago	0.322	0.518	0.025	0.043

Hinundayan	0.26	0.63	0.03	0.048
Dapa*	0.155	0.21	0.207	0.14
Tandag*	0.304	0.343	0.205	0.104
Bislig*	0.158	0.17	0.132	0.165

Others - Assumed stations
* - PHIVOLCS stations
** - NAMRIA stations
Others - Assumed stations

4. Conditions for Computation

The calculation of numerical tsunami simulation is set to a single layer computational domain with a latitude 08° - 14° N and longitude of 123.5° - 129°E. We set 1-arc min and 30-arc sec grid interval for GEBCO and merged GEBCO and digitized bathymetry points. Parameters of tsunami wave propagation for different bathymetry are summarized in Table 8. The maximum water depths for GEBCO 1-arc min and 30-arc sec are 9,986.87m and 10,025.98m respectively. On the other hand, the merged GEBCO 1-arc minute and digitized bathymetry points for interval grid of 1-arc minute is 10,259.53m and 30-arc sec is 10,258.22m. The total computation time was 360 minutes and this equivalents to 10,800 time steps.

Table 8. Summary of parameters used in tsunami height and travel time simulation.

Bathymetry source	Grid dimension (nx / ny)	Spatial grid size (m) (Δx / Δy)	Temporal grid size (sec)
GEBCO 30-arc second grid with grid interval of 1-arc minute. GEBCO 1-arc minute + Digitized bathymetry points with grid interval of 1-arc minute.	330 / 360	1821.17385 / 1843.28956	2.0
GEBCO 30-arc second grid with grid interval of 30-arc seconds. GEBCO 1-arc minute + Digitized bathymetry points with grid interval of 30-arc seconds.	660 / 720	910.59692 / 921.64478	

Table 9. Summary of parameters used in the computation of tsunami inundation.

Region	Latitude ($°N$)		Longitude ($°E$)		Grid size (nx/ny)	Spatial grid size (arc secs)	Bathymetry data source
1	8.0	14.0	123.5	129.0	330/360	60	GEBCO 30”
2	10.5	12.0	125.16667	126.25	195/270	20	GEBCO 30”
3	10.83333	11.75	125.33333	126	360/495	6.66667	GEBCO 30”
4a	11.4833	11.7167	125.417	125.567	243/378	2.22222	GEBCO 30”+SRTM3”
4b	11.2833	11.4833	125.467	125.683	351/324	2.22222	GEBCO 30”+SRTM3”
4c	11.1	11.2833	125.517	125.8	459/297	2.22222	GEBCO2014 30”+SRTM3”
4d	10.8833	11.1	125.7	125.883	297/351	2.22222	GEBCO 30”+SRTM3”