INSTITÚTO DO PETRÓLEO E GEOLÓGIA

INSTITUTO – PÚBLIKU (IPG-IP)

ANÁLISE PERIGOSIDADE TSUNAMI IHA TIMOR LESTE UTILIZAUN DADOS DETERMINISTIK

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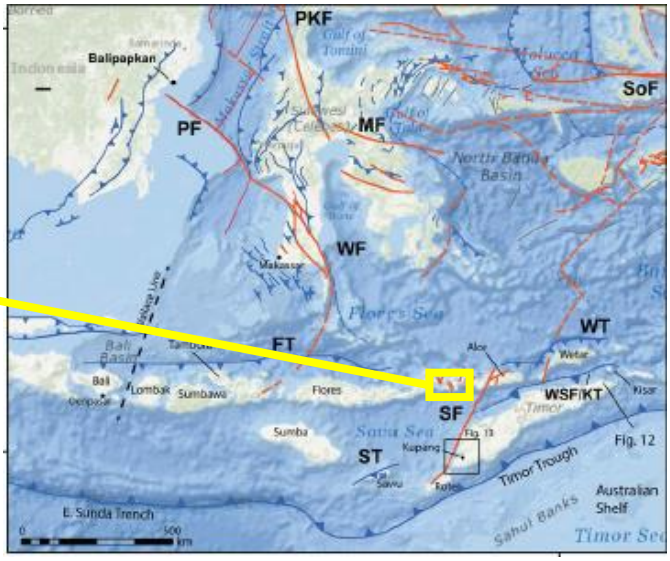
1. Introdusaun

Timor-Leste nudar ilha nebe lokaliza iha Noroeste Australia no Sudoeste Indonesia no iha plakas tolu nebe besik liu ba iha zona magma (ring of fire zone), no Timor-Leste mos lokaliza iha zona nebe seismisidade ass no sistema falha nebe komplikadu nebe akontese iha territorio Timor laran tomak, hanesan akontesimentu iha parte Leste iha ilha Aru trough (Lovholt et al, 2012), Oeste Savu thrust, Norte iha Wetar thrist, Wetar strai fault/Kisar thrust, no sul mak Timor trough (Harris and M ajor, 2016)

1857, 13 May, northern East Timor A violent earthquake threw people to the ground. Part of the walls of the fort collapsed and ground subsidence was observed. A tsunami with four waves struck the bay and reached 3.1 m high. Fissures were created on the beach. The quake was also 'very strong' in Hera, Laclo, Lautem, Lale and Batugade. A mud volcano erupted near Viqueque. At Liquica village, a tsunami flooded almost the entire village. A hill sank on Palau Kambing (north of Dili) killing more than 36 persons. The quake was felt in Kupang (285 km SW of Dili) and Ambon (600 km to NE). Aftershocks were felt through June when the record stops.

Likely source: Wetar Strait Thrust or Wetar Thrust.



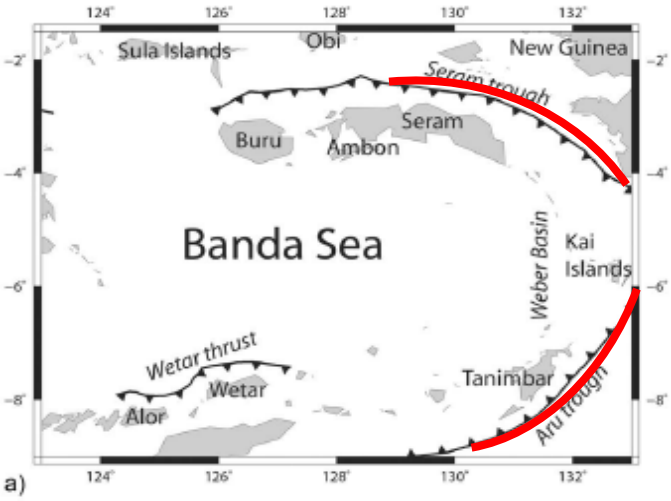


Fig. 1 Mapa lokalizasaun no falha ativu iha Timor Osidental, no regiaun Sul Sulawesi. FT. Flores Thrust; MF, falha Matan; PKF, Falha Palu-Koro; PF, Falha Pasternoster t; SF, Falha Semau Sof. Soong; ST. Savu Thrust, WF. Falha Walanae; WST/KS. WWetar Thrust.

1.1 Istoria Seismiku no Tsunami

Baseia ba referensia akonstesementu Tsunami iha 1629 ho megatrust no falha Tanimbar, ondas tsunami as 15,1 m konsege grava (Gravasaun) iha Banda Niera (Liu and Harris 2013)

Length (km)	Width (km)	Strike 1 (°)	Strike 2 (°)	Dip (°)	Depth (km)	Max slip (m)	Min slip (m)
South source–Tanimbar Trough (maximum M_w: 9.8; minimum M_w: 9.2)							
450	112	220	260	10	20	40.9	14.96
East source–Seram Trough (maximum M_w: 8.8; minimum M_w: 8.2)							
500	97	118	160	10	15	11.6	6.2

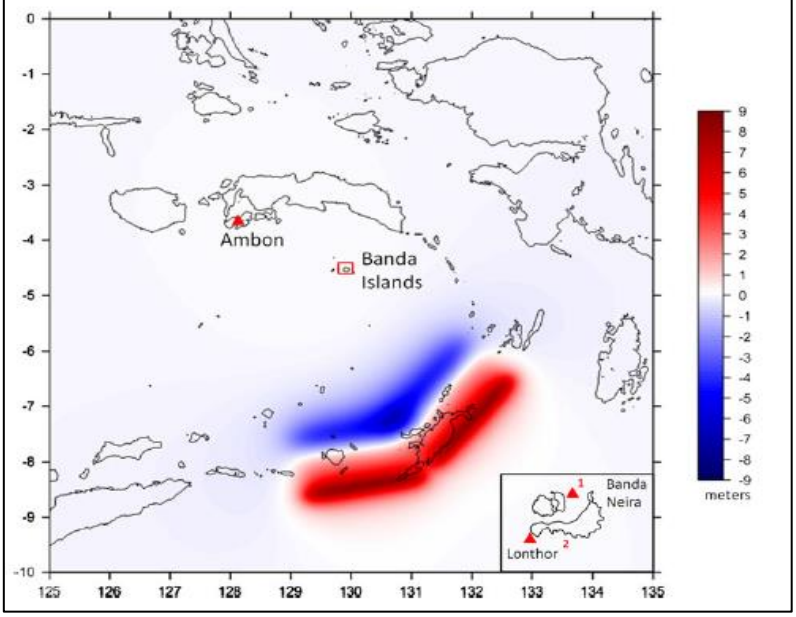


Fig. 2 Falha Megathrust iha ilha Tanimbar (Liu no Harris 2013)

2. Objetivo

Objetivo 3 mak sei halo iha peskija nee

1. Estimasaun tempo atu to'o (ETT/ETA)
2. Estimasaun ondas tsunami nia ass
3. Mapa inundasaun tsunami

2.1 Problemas

- Oins atu atu hatene Estimasan Tempu atu to (ETT/ETA) iha Timor-Leste baseia ba dados (Deterministik) tsunami no terramutu (rai nakadoko)
- Oinsa buka hatene tsunami nia ass nebe produse iha territorio laran tomak
- Oinsa buka hatene tsunami nia distansia nebe sae iha rai maran iha area costeira

3. Metodologia

Metodologia nebe mak utiliza iha parte ne mak oinsa bele uja dados sekundaria (historical data of Earthquake and Tsunami) no setup dados ba komputador. Dados nebe mak iha hanesan parametru terramutu (rai nakadoko), dados bathimetria, dados topografia. Tuir mai simulasaun uja software COMCOT (Cornell Multi-grid Couple tsunami Model), no - GMT (Generic Mapping Tools), ArcGIS 10.4.1

$$\frac{\partial \eta}{\partial t} + \frac{\partial hu}{\partial x} + \frac{\partial hv}{\partial y} = 0$$

$$\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} + \frac{gn^2}{h^{4/3}}u\sqrt{u^2+v^2} = -g\frac{\partial \eta}{\partial x}$$

$$\frac{\partial v}{\partial t} + u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y} + \frac{gn^2}{h^{4/3}}v\sqrt{u^2+v^2} = -g\frac{\partial \eta}{\partial y}$$

Nebe η = elevasaun superfisi (m); h = total profunidade bee (m), v = velocidade medio (m/s); ρ = todan bee (kg/m^3); g aselerasaun gravidade (m/s^2)

3.1 Dados Terramutu (rai nakadoko) no Tsunami Passado (historical data of earthquake and tsunami)

Parametru falha scenario hat (4) hodi halo simulasaun ba ondas tsunami. Dados hotu antes uja ona hodi halo simulasuan no resultadu hatudu afeita nebe signifikadu ba Timor-Leste liu-liu iha area Dili.

- Tanimbar 1629, resulta husi Aru though no produce 15.1 m ondas tsunami nebe grava hela iha Banda Niera (Liu, no Harris, 2013)
- Wetar thrust 1957, peritus dahuluk fosai katak ema vitima hodi mate tamba ondas tsunami ho metro 3.1 nebe observa iha ilha Kambing, nebe besik mai parte norte Dili.

Length (km)	Width (km)	Strike 1 (°)	Strike 2 (°)	Dip (°)	Depth (km)	Max slip (m)	Min slip (m)
South source–Tanimbar Trough (maximum M_w: 9.8; minimum M_w: 9.2)							
450	112	220	260	10	20	40.9	14.96
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Location	Region	L (km)	W (km)	D (m)	μ (GPa)	H_{min} (km)	θ (deg)	M_w
Bali/Lombok	Bali / Flores Seas	155	80	5.5	10	0	30	7.8
Flores		153	80	5.5	10	0	30	7.8
Buru and Ceram		202	80	8	20	0	20	8.2
Weber Basin	Banda Sea	303	80	5.6*	15	0	20	8.1
Ambon Island		179	80	7	15	0	40	8.1
Wetar Island		105	55	4	10	0	30	7.5
Eastern Minahassa	Northern Sulawesi and	184	80	6.5	10	0	25	7.9
Western Minahassa	northern Moluccas	179	80	6.5	10	20	25	7.9
Sangihe double subduction		178	70	6	10	0	80	7.8
Biak Island	New Guinea	193	75	8.2	30	0	20	8.3
Eastern Irian Jaya		193	75	8.2	30	0	20	8.3
Papua New Guinea		193	75	8.2	30	0	20	8.3
Cotabato Trench	Southern Philippines	170	80	3.4*	30	0	22	8.2
Philippine Trench S		176	100	10	30	0	20	8.4
Philippine Trench N		166	100	10	30	0	20	8.4

[a] *L*, *W* and *D* are fault length, width and slip, respectively; μ is rigidity (shear modulus); H_{min} is the minimum fault depth (* indicates a segmented fault, with the mean value of the slip reported); θ is dip angle; M_w is moment magnitude.

Fig 3. Parametru falha nebe uja no simulasuan numerical

3.2 Preparasaun Dados

Utilizasaun pontos coordenadas 4 nebe mak kobre Timor tomak no ikus liu mak foka ba fatin nebe mak sai targetu ba akontesementu estimasaun tsunami tempo too (ETT/ETA), tsunami nia ass no inundasaun tsunami, iha parte nee foka liu ba sidade Dili sai hanesan fatin urbana nebe centralizadu. Prosesu tuir mai preparasaun dadus iha fase 3 mak hanesan: Preparasaun dados, prosesu dados no inisial (resultadu)

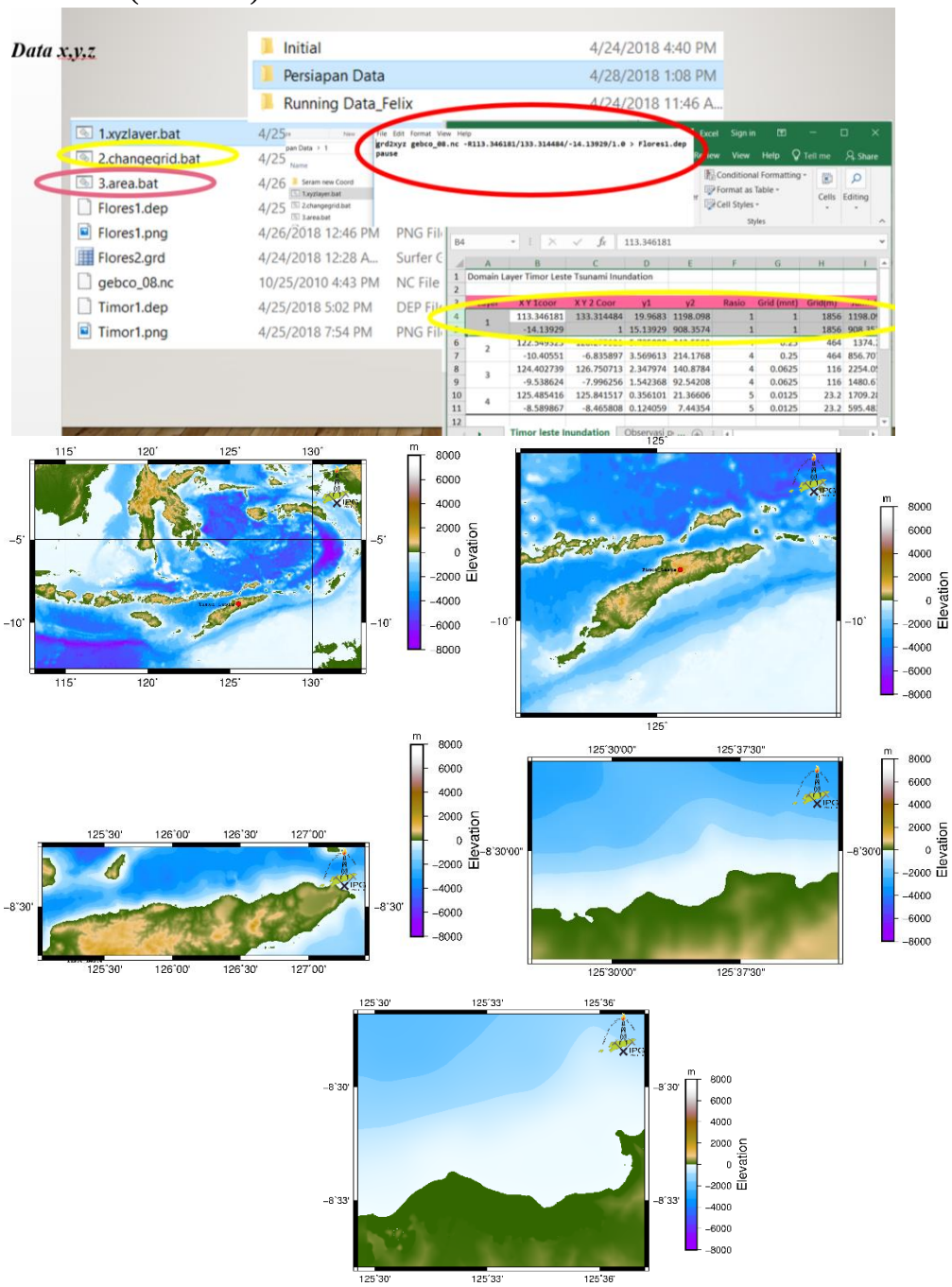

Fig 4. Indikasuan fatin ba simulasaun iha Territorio Timor-Leste

Atu hetan dados ba estimasuan tempo too (ETT/ETA) no estimasuan ondas nia ass, persija observa ondas tsunami iha area costeira, nebe mak utiliza fatin 10 nebe mak lokaliza iha teritorio timor laran tomak. Mak hanesan:

- Covalima
- Manufahi
- Viqueque
- Lautem
- Baucau
- Manatuto
- Dili
- Liquisa
- Bobonaro
- Oequisi

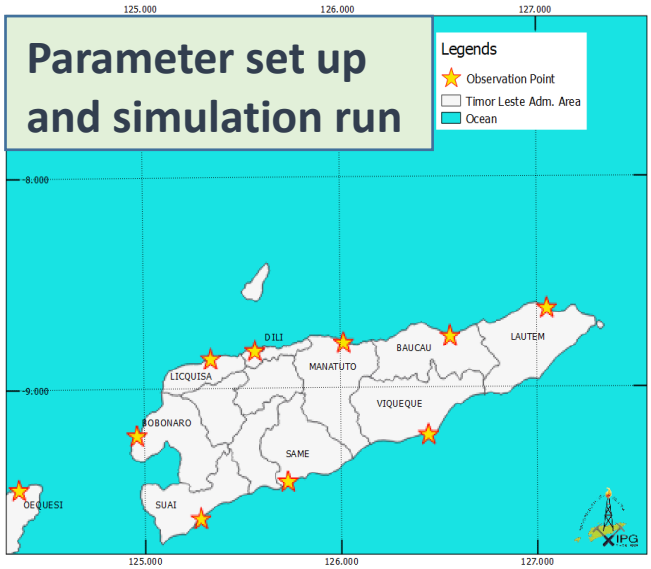

Fig 5. Prerasaun ba fatin atu hodi simulasaun (Timor Leste)

3.3 Prosesu dados

Utilizasaun software Comcot hodi prosesu dados liu-liu hatama dados hotu ba iha software atu nune bele prosesu dados hotu, tuir parametru nebe mak sei hatudu iha okos

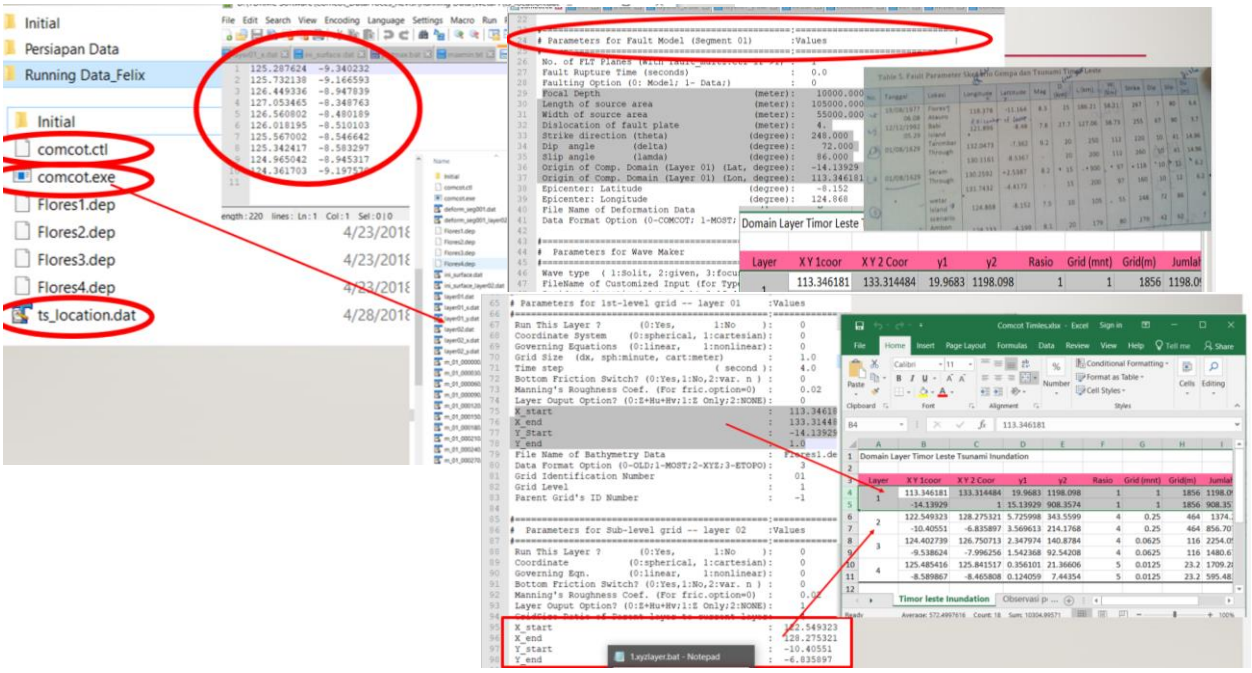

Fig 6. Utilijazsaun software Comcot ba posesu dadus

4. Resultadu no Diskusaun

4.1 Initial (Estimasaun Tempo To'o (ETT/ETA)

Initial nudar prosesu ida nebe mak atu hatudu resultadu focal mechanism nebe sei resulta tsunami iha fatin nebe determina tuir dados nebe rekolha, mak hanesan Wetar thrust, nebe hatudu iha imagem okos.

Baseia ba dados antigo nebe mak utiliza hodi halo simulasaun hanesan dados referensia husi Tanimbar 1629 no Wetar Thrust 1857, hatudu katak inisiu ondas nebe mak produs husi Tanimbar Megathrust ho ass >6 m bele to iha capital Dili ho estimasaun tempo too (ETT/ETA) no estimasuan ondas tsunami ass nebe mak demora ituan, maibe iha mos akontesementu nebe mak besik liu capital Dili mak resulta Wetar thrust (7.5 Mw) ho inisiu ondas nebe ass ho metro 3 no aselerasaun ondas iha 0.98 m no to iha capital Dili no ho tempu 11 minutes maibe Liquisa ho tempo 7 minutus sedu liu. Akonstementu simulasaun disaster tsunami nebe sei resulta transporta sedimentus lubuk hodi akumula iha rai maran.

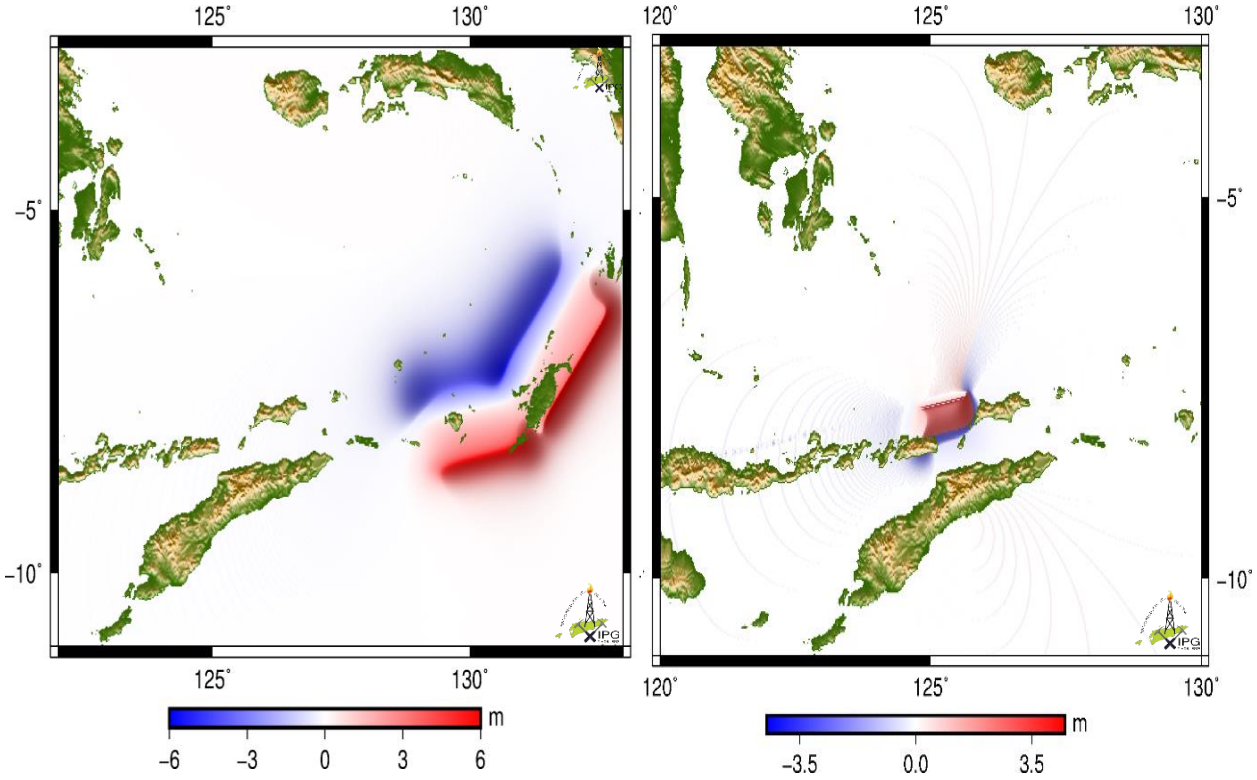

Fig 7. Paramentru falha nebe utiliza dados deterministik

Location	Estimated Time of Arrival (Minute)			
	Seram 1629	Wetar 1857	Sumbawa 1977	Shortest
Lautem	NA	NA	NA	NA
Baucau	NA	NA	NA	NA
Manatuto	103	18	NA	18
Dili	NA	11	NA	11
Liquisa	107	7	NA	7
Bobonaro	NA	44	NA	44
Oequesi	NA	NA	NA	NA

Location	Estimated of Tsunami Wave Hight (M)			
	Seram 1629	Wetar 1857	Sumbawa 1977	Highest
Lautem	0.29	0.03	0	0.29
Baucau	0.6	1.02	0.19	1.02
Manatuto	1	1	0.48	1
Dili	0.56	0.98	0.47	0.98
Liquisa	0.09	0.73	0	0.73
Bobonaro	0	0.06	0	0.06
Oequesi	0	0	0	0

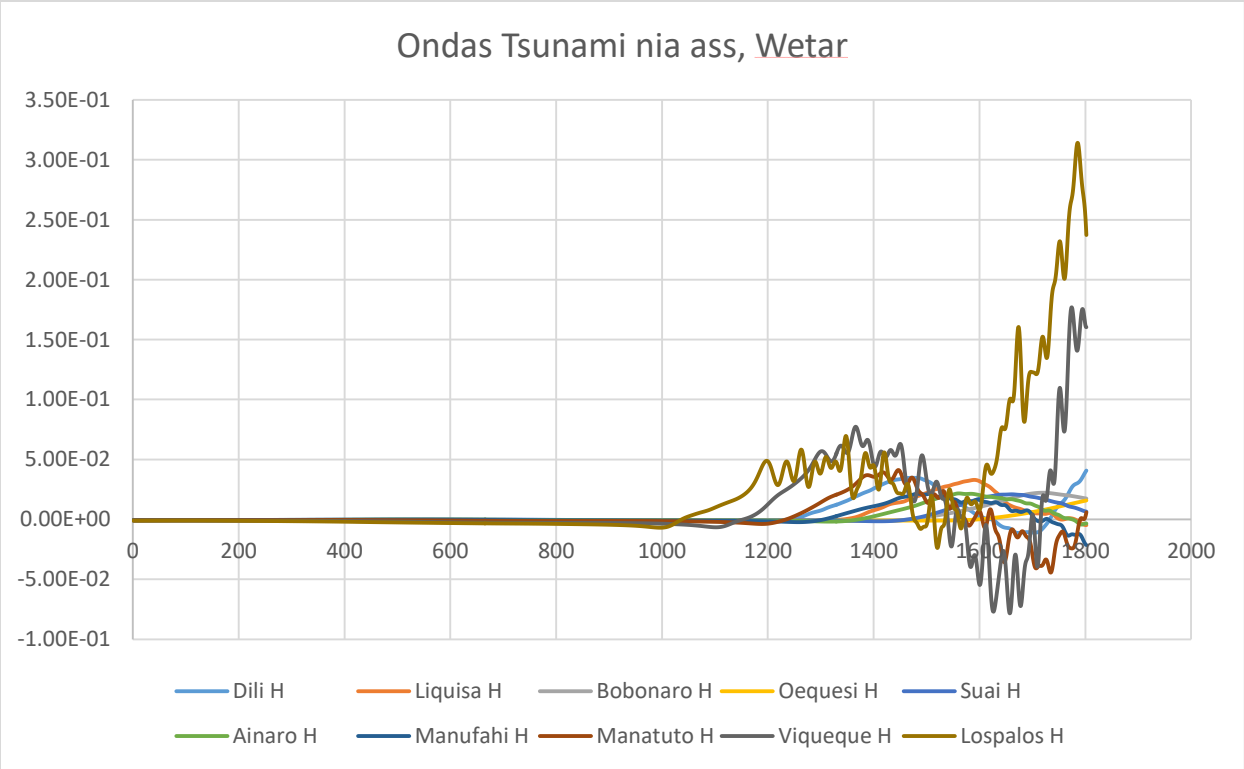

Fig 8. Estimasaun Tempu to'o (ETT/ETA) no ondas nia ass

4.2 Estimasuan Inundasaun Tsunami

Inundasaun tsunami nebe produse husi Wetar Megathrust iha tinan 1857 sei kobre 2.4 km rai maran, no inundada kobre 1272.9 Ha rai maran iha capital Dili, ho klean nebe various. Area nebe besik liu ba portu nudar fatin ida nebe hetan afeitadu ondas makas, causa husi forma naturalmente nudar baeia (narrow bay). Area aveita makas ba inundasaun tsunami maka fosai tuir kor mapa nebe iha okos (kor mean area afeitadu makas, kinor area afeitadu medio, no matak area afeitadu menus)

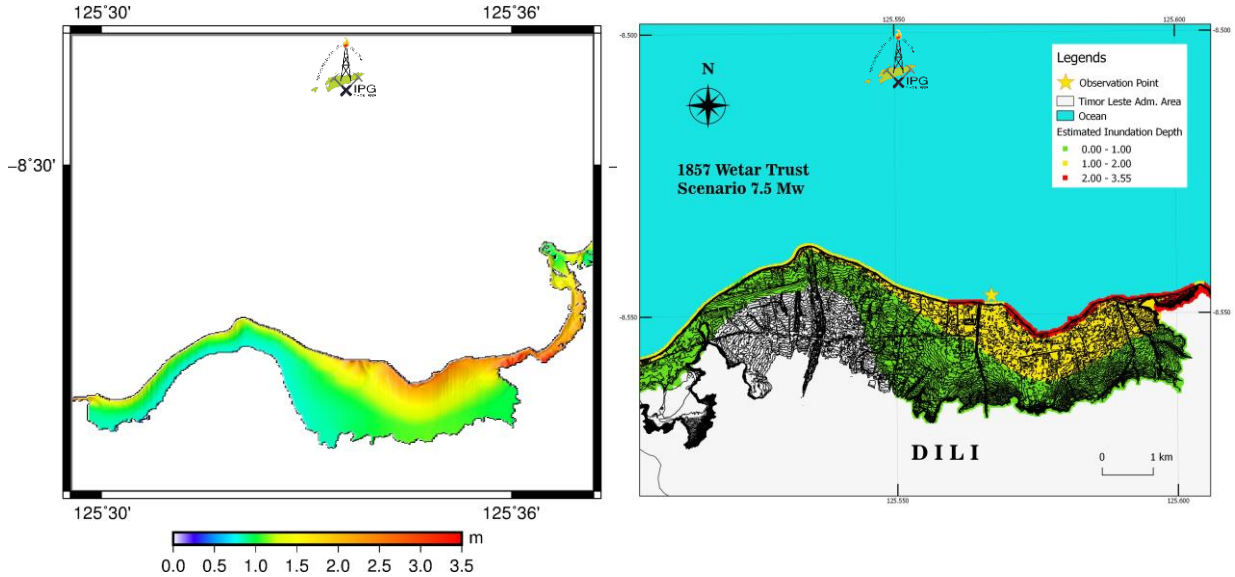

Fig 9. Mapa Simulasuan Inundasaun tsunami iha capital Dili

5. Conclusaun

Tsunami nebe husi scenario hat (4) akontese husi parte norte Timor-Leste, Dili, Liauisa, Baucau, Lospalos, no Bobonaro. Husi Wetar thrust resulta Estimasaun tempo toó (ETT/ETA) ho tempo nebe limiti no durasaun 11 minutus, ho ponto observasaun 200 metrus husi tasi nining.

Estimasuan ondas tsunami nebe ass (implikasaun husi Wetar thrust) mak iha Baucau ho nia medida 1.85 metrus, maibe Dili ho deit 1.0 metru. Ondas nebe akumlua iha tasi, sei iha diferensia wainhira iha rai maran.

Area hirak nebe mak inudada husi Wetar Megathrust resulta 3.55 metrus (Inundation depth/EID), iha parte portu Dili nebe mos reduse ba sentimetrus balun depois 2.4 km to iha rai maran. Simulasaun nebe mak simula akumula iha 1.272.9 ha.