One Day Workshop in The Kingdom of Tonga

A Socially and Environmentally Sustainable Country by the Local Community and Resident

THE SIMPLER, THE BEER !

2014. 12. 8

Dr. Toru KIMURA (Kyoto University in Japan)
Dr. Masaki ARIOKA (NPO SLIIM Japan)

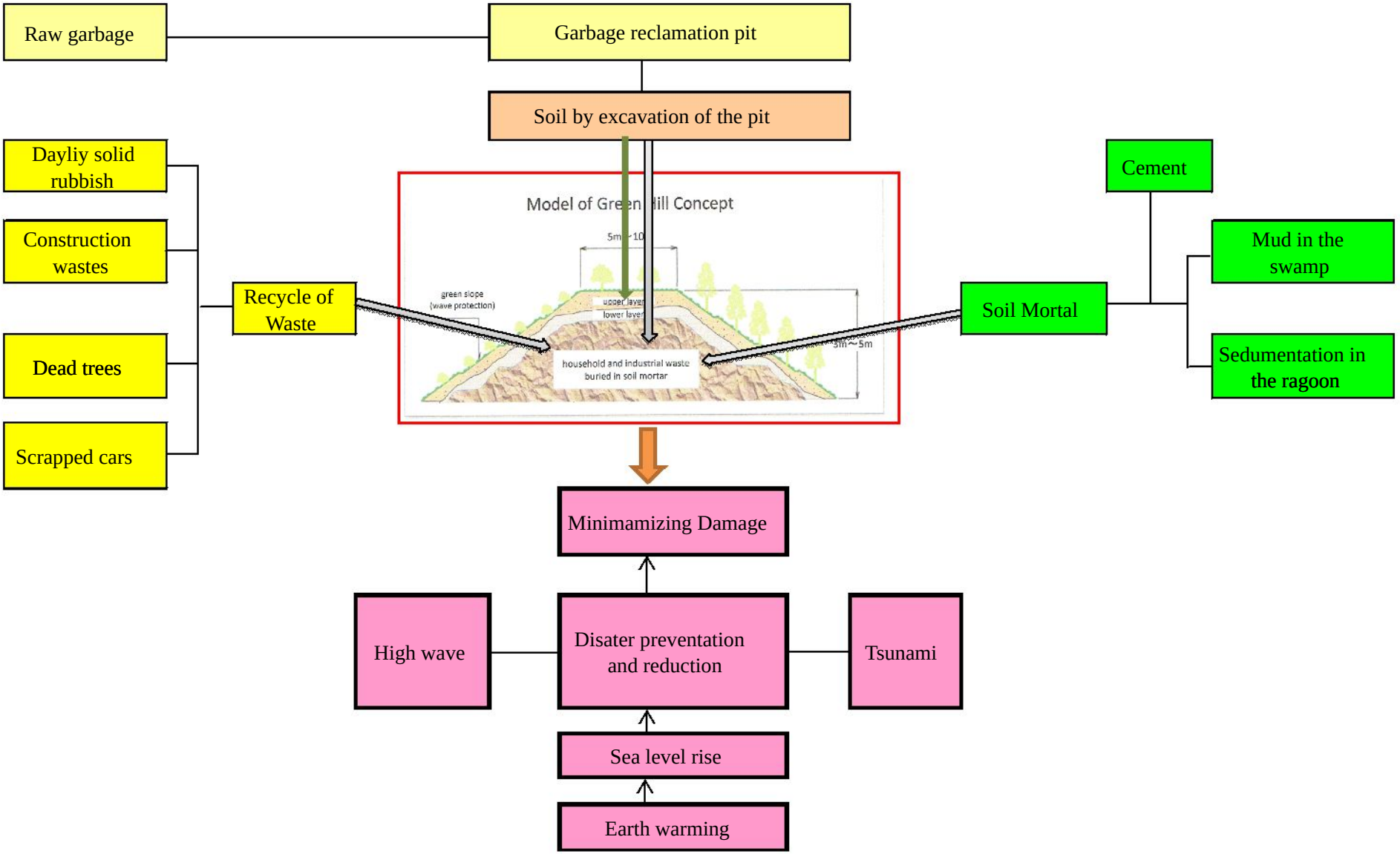
Adaptation for Coastal Inundation due to Climate Change and Solving the Waste Disposal Problem in the Kingdom of Tonga

Dr Masaki Arioka
Executive Director
Society for Lifecycle Infrastructure Management (SLIM)
Specified Non-Profit Organization in Japan

History of Earthquake in South Pacific
(21 century)

Main Country	Tonga	Samoa	Solomon Islands	Solomon Islands	Indnesia Ache
Date	2006.5.3	2009.9.29	2007.4.2	2013.2.6	2004.12.26
Death Toll (Injured)	?? (??)	189 (several hundred)	52 (??)	5 (??)	220thousands (130thousands)
Magunitude	7.9	8.1	8.1	8	9.3
Hight of Tsunami	??	4.5m - 6m (4imes)	2.0 - 3.5m	about 1.5m	average 10m, maximum 34m
Tongs	??	9 (5)	Nil	Nil	Nil

Green Hill by Waste and Mud (WMGL)



Background of Current Proposal

2011.3.11: Higashinihon Earthquake

(Proposal of Green Hill Concept for Tsunami Debris)

2012.7: Disaster Management against Tsunami in to Tongan Government

(1)Crossing (Pedestrian) Bridge over the Lagoon

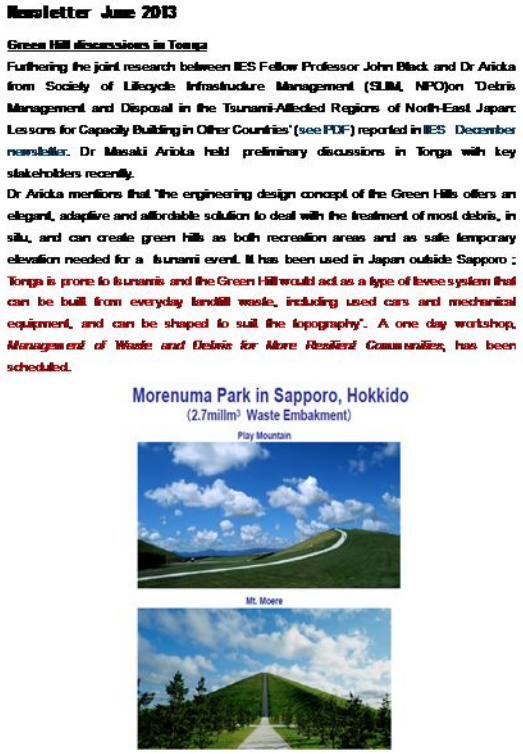
(2)Application of Green Hill Concept along the Sea Coast

2012.9.18: The 8 th APRU Research Symposium in Japan

(Debris management and disposal in the tsunami -affected regions of North-East Japan: Lessons for capacity building in other countries)

2012.12: Collaboration with University of NSW to Approach to WB

(Newsletter December 2012 and June 2013)



Newsletter June 2013

Green Hill discussions in Tonga

Furthering the joint research between IES Fellow Professor John Black and Dr Arioka from Society of Lifecycle Infrastructure Management (SLIM, NPO)on 'Debris Management and Disposal in the Tsunami-Affected Regions of North-East Japan: Lessons for Capacity Building in Other Countries' (see PDF) reported in IES December newsletter. Dr Masaki Arioka held preliminary discussions in Tonga with key stakeholders recently.

Dr Arioka mentions that "the engineering design concept of the Green Hills offers an elegant, adaptive and affordable solution to deal with the treatment of most debris, in situ, and can create green hills as both recreation areas and as safe temporary elevation needed for a tsunami event. It has been used in Japan outside Sapporo ; Tonga is prone to tsunamis and the Green Hill would act as a type of levee system that can be built from everyday landfill waste, including used cars and mechanical equipment, and can be shaped to suit the topography". A one day workshop, *Management of Waste and Debris for More Resilient Communities*, has been scheduled.

Morenuma Park in Sapporo, Hokkido

(2.7millm³ Waste Embakment)

Play Mountain

Mt. Moere

2014.2.12: Proposal to ERCA (Environmental Restoration and Conservation Agency

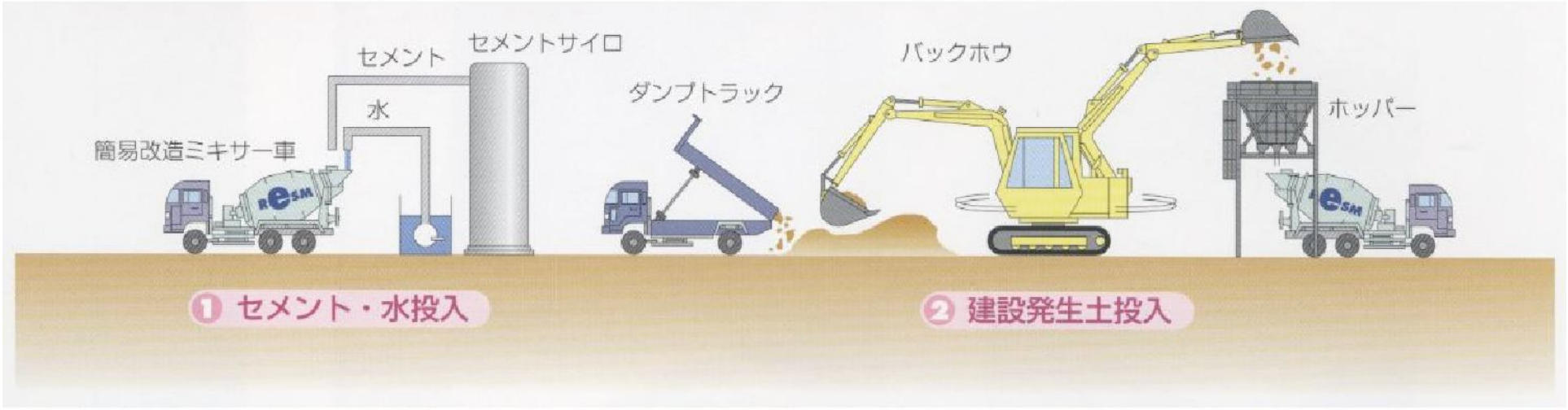
2014.8.29: Supporting Letter by the Ministry of the Lands and Natural Resou rces

ReSM

Re-produced Soil Material Method

ＲｅＳＭ Procedure

(Mud Water by using Special Mixing Car)



土砂積み出しホッパー

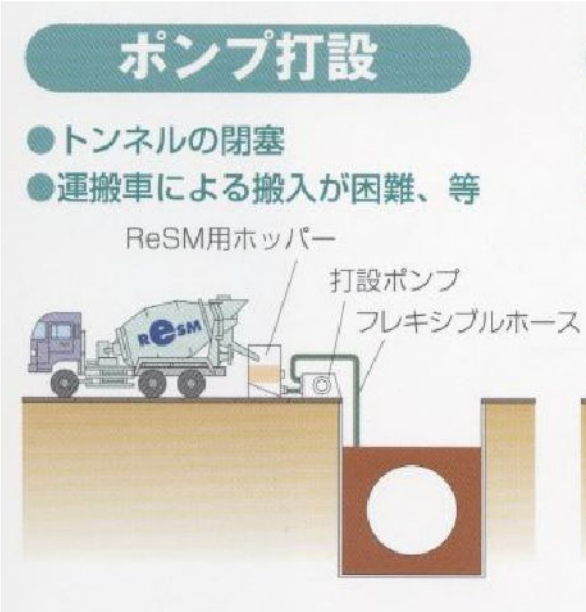
固化材サイロ

原料土積みこみ

原料水，固化材積みこみ

ReSM Application

Pump Placing



Shoot Placing

Pump Car Placing

Example for Open Cut Method of Subway Station

Side Filling

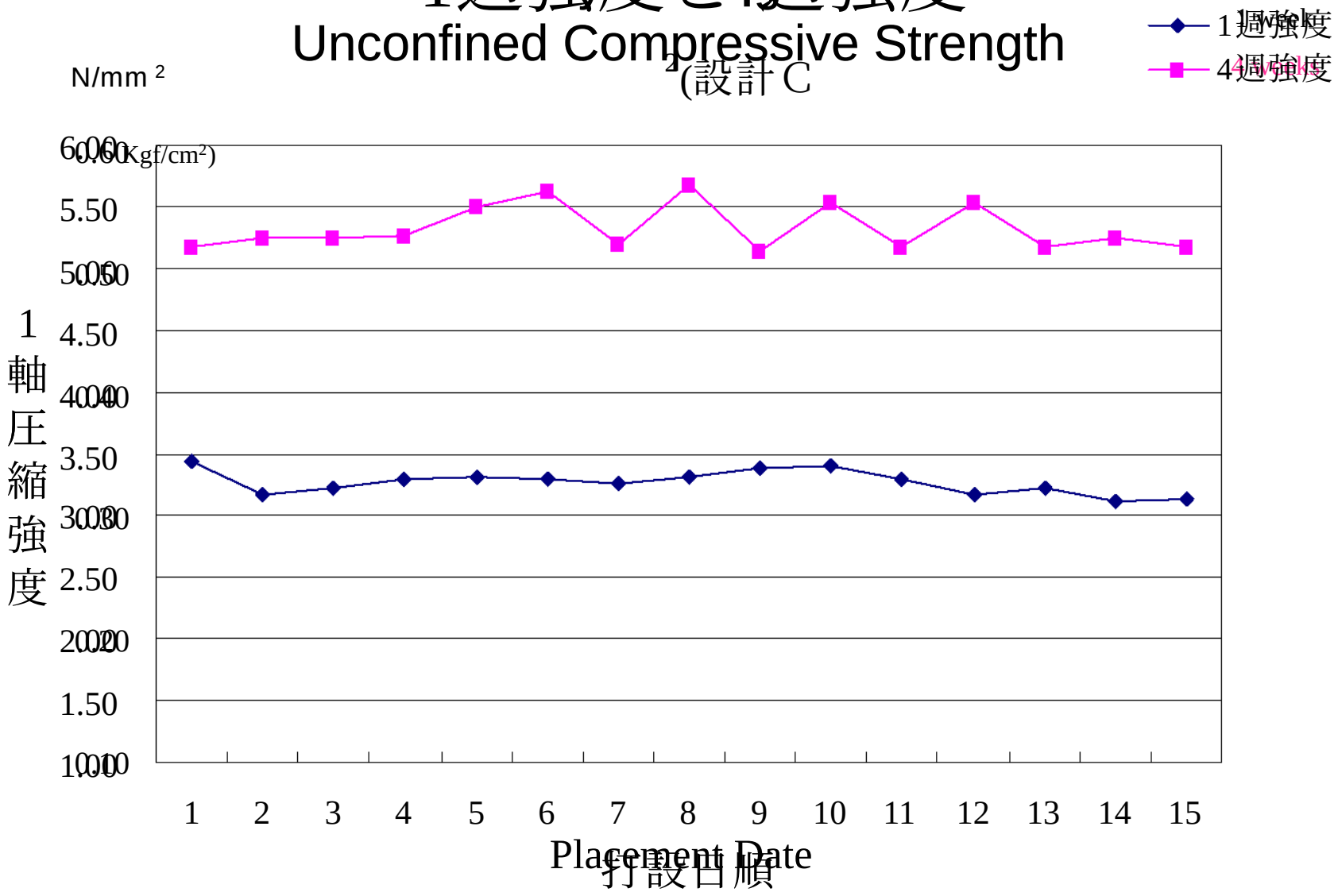
Reclaiming the Space above Structure

ReSM Mix Proportion :Example (Backfilling)

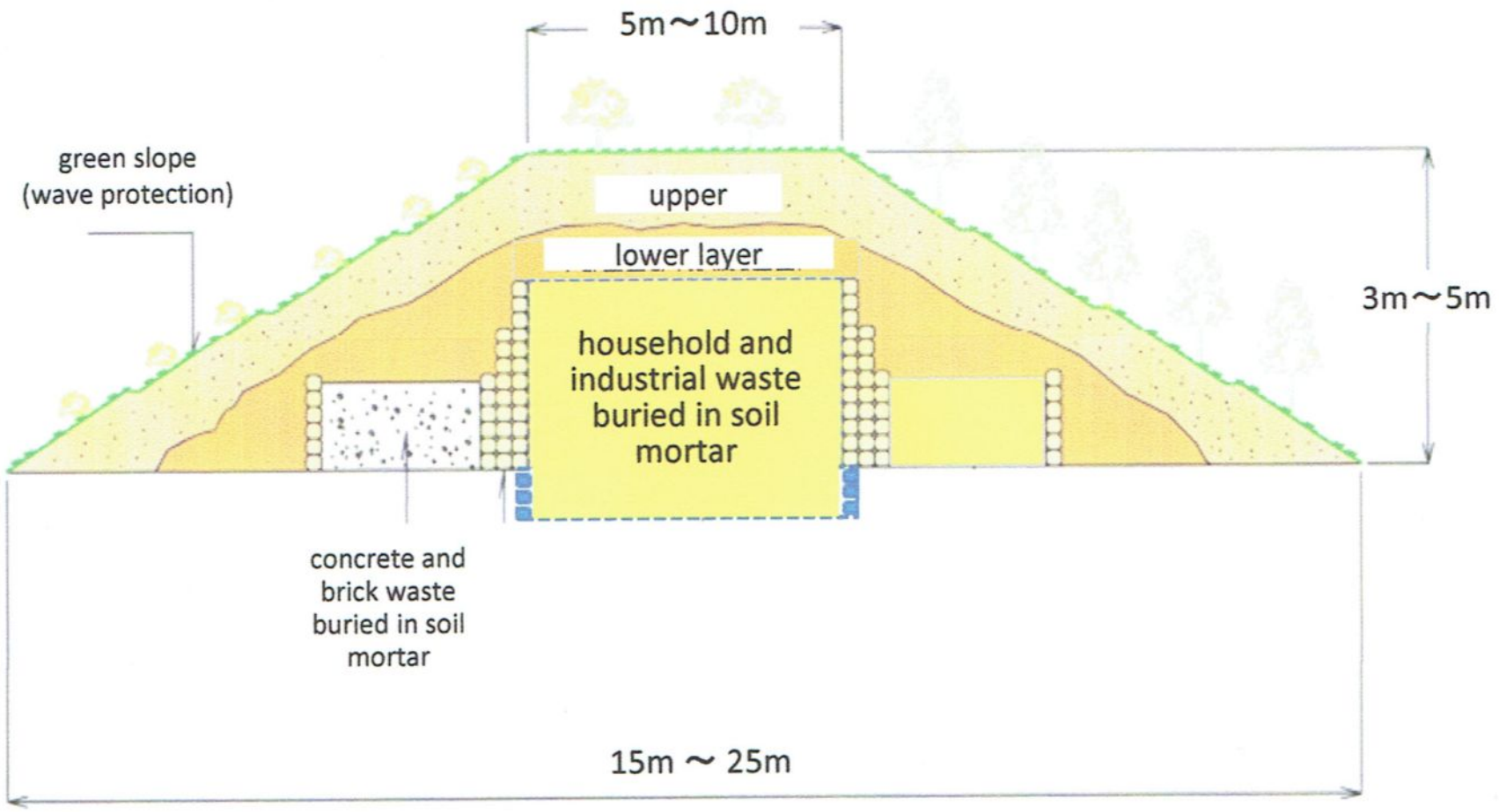
	Standard Mix Proportion (kg/m³)		
Design Strength 0.55N/mm²	Cement	Water (Sea Water)	Soil (Surface Dry)
	190	722	562

1週強度と4週強度

Unconfined Compressive Strength (設計 C)



Design Outline of Green Hill Concept



Anaerobic Landfill

Sustainability

福岡県教育委員会は30日、古代九州の統治拠点だった大宰府（同県太宰府市）の防衛施設「水城（みずき）」跡で、地盤補強のため土塁の底部に敷きつめた枝葉が、664年の築造時から1350年間、緑色を保った状態で出土したと発表した。

県教委によると、見つかったのは「敷き粗朶（そだ）」と呼ばれる補強材で、ブナ科などの樹木の枝葉が使われていた。水分が多い粘土の中で酸素に触れなかったため腐敗せず、葉脈が確認できるほど良好な状態だった。

水城は663年の「白村江の戦い」で唐と新羅に敗れた日本が、朝鮮半島の高度な技術を使って築造。全長約1・2㌔の土塁と堀で構成され、調査で火山灰土や河川の砂、粘土を何層も積み重ねているのが確認された。

発掘担当者は「緊急性が高い工事ながら、計画的に土砂を集め、堅固に造ったことが分かった」としている。

1913年の東京帝国大学の研究者らによる調査でも、今回とほぼ同じ成果が報告されている。県教委の入佐友一郎技術主査は「約100年前にあった調査の精度の高さに驚いた」と話している。

福岡県太宰府市（手前）と大野城市にまたがる、「水城」跡で確認された土塁の断面（30日）

Flowability ? Clay

Waste

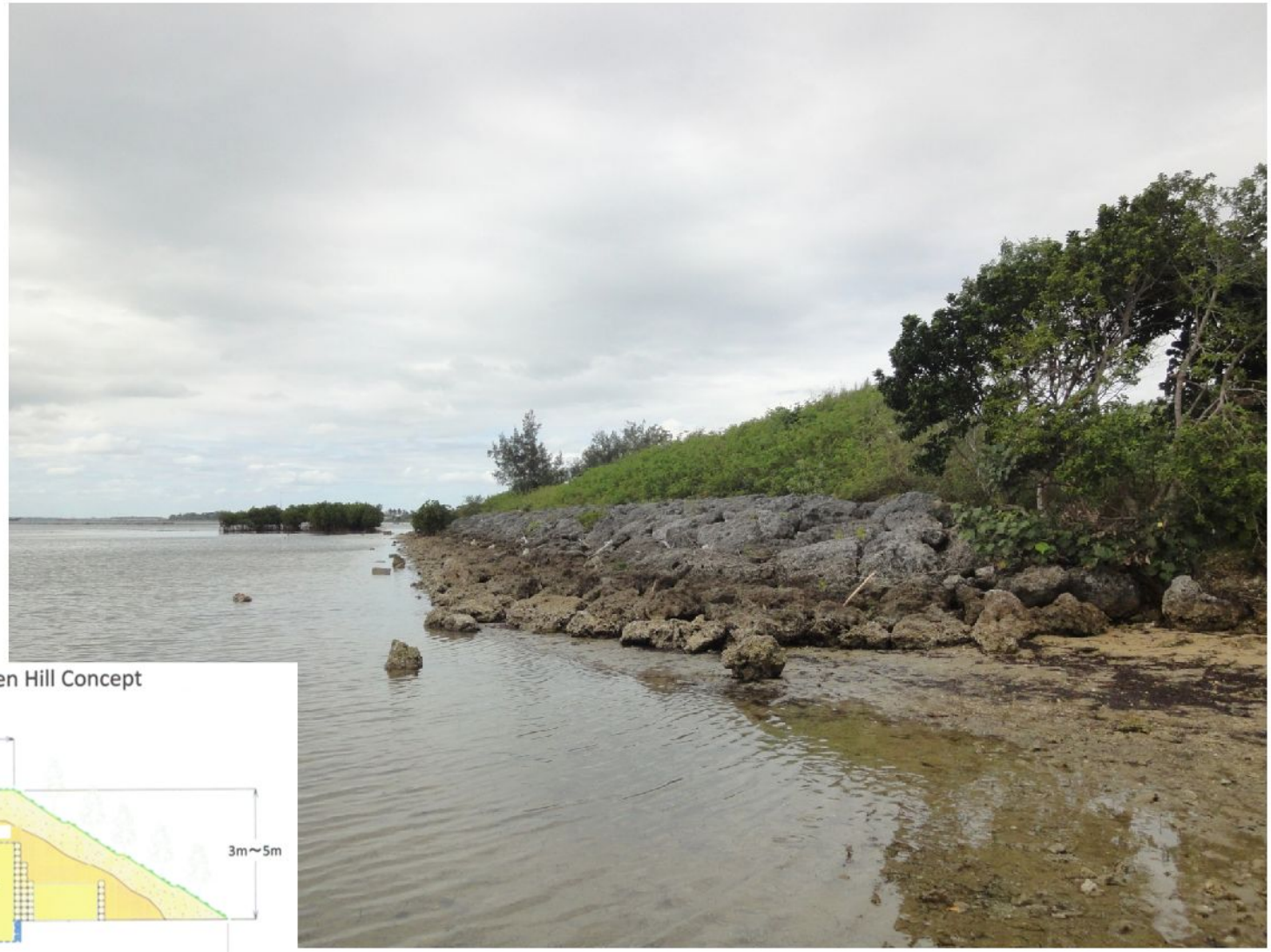
Mud in Swamp

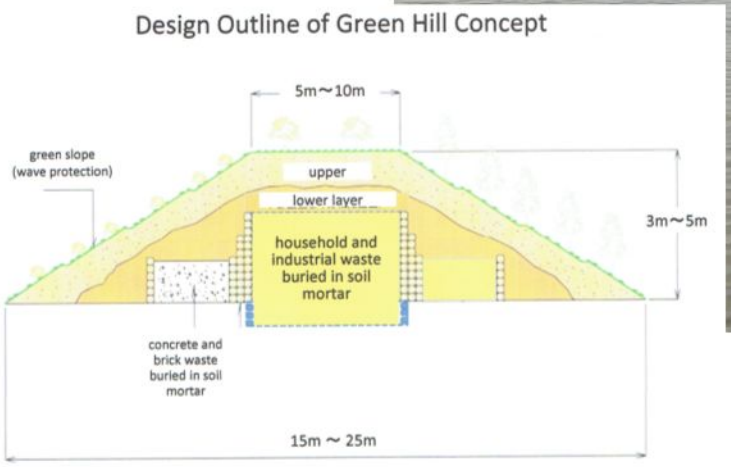
Scraped Car

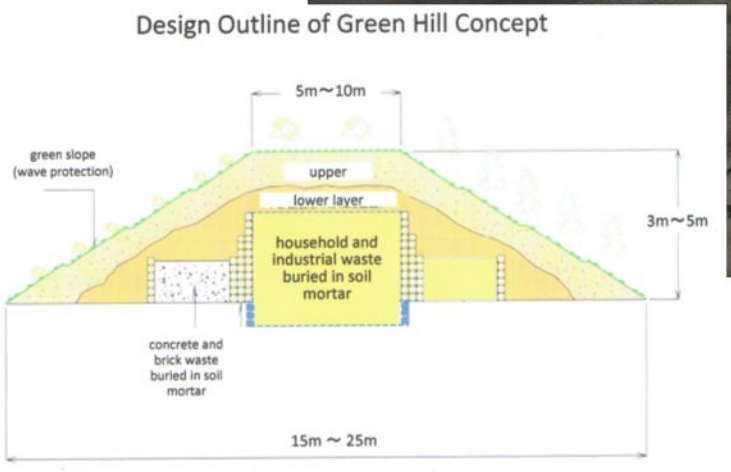
Dead Tree

Daily Waste Landfill Place (2012.7)

Masonry Coastal Revetment






Design Outline of Green Hill Concept
5m～10m
green slope
(wave protection)
upper
lower layer
household and
industrial waste
buried in soil
mortar
3m～5m
concrete and
brick waste
buried in soil
mortar
15m ～ 25m

NUKU ’ ALOFA

THREE PHASE OF EXECUTION SHEDULE OF CAPACITY BUILDING PROJECT (For three years)

- Phase One -

Consensus Formation with Related Authorities and Community Leaders and Confirmation of Feasibility by Basic Feasibility Study

(1) Preparatory Stage

- Initial stakeholder Workshop (designed and evaluated by Engineers)
- Discussion and Consensus Formation with Related Authorities and Community Leaders
- Confirmation of Feasibility to Proceed (submission of Inception Report for Phase 2)

(2) Initial Investigation Stage

- Effective Use of Waste and Marsh/Wetland Sludge
- Fostering Awareness of Security/Safety in Inundation Control by Pilot Levee Construction
- Identification of Project Feasibility by Basic Feasibility Study
- Establishment of Consensus Formation of Authority and Community

THREE PHASE OF EXECUTION SHEDULE OF CAPACITY BUILDING PROJECT (For three years)

- Phase Two -

- Confirmation of Various Engineering Factors Required for Project Realization
- Confirmation of Effectiveness of Soil Mortar Using Locally Available Sludge

  Various day-to-day waste materials, including tsunami caused rubble, as the case may be, are possibly used to make up a part of the coastal levee body together with deposited materials in wetlands and lagoons in order to mitigate expected storm surge/high tide disasters.

THREE PHASE OF EXECUTION SHEDULE OF CAPACITY BUILDING PROJECT (For three years)

- Phase Three -

Pilot Levee Construction as Starting Point for Mid - to Long-Term Project Realization

- Pilot Levee Construction Taking Mid to Long Term Project Realization
- Community Members' Recognition of Importance of Waste Separation and Its Usefulness
- Community Members' Experience to Participate in Soil Mortar Levee Construction as Workers
- Formation of Project Execution Ability of Authority and Community Members to Execute Project
- Project evaluation and effectiveness of stakeholder engagement with qualitative surveys

FUTURE OBJECTIVES

Securing Sustainability after 3-Year Project Completion

(1) This theme is not only for this main island but also all South Pacific countries. The University of South Pacific may take initiative to resolve relevant issues environmentally, technically, economically and for fund raising. We recommend several countries concerned in this matter to establish a committee and approach JICA, WB and/or other organizations.

(2) Mid- to Long-Term Project Period

It will take approximately 30 years to complete levee for the north coast residential and commercial area assuming yearly progress is 100m to 200m.

(3) SLIM Japan and University of NSW Australia are willing to get involved in the arrangement of financial aid acquisition for the project cost in collaboration with above mentioned committee based on the capacity building procedure.