High-Level 14th Regional EST Forum in Aichi, Japan

19 October 2021

Climate and Disaster Resilient Transport System and Infrastructure Development

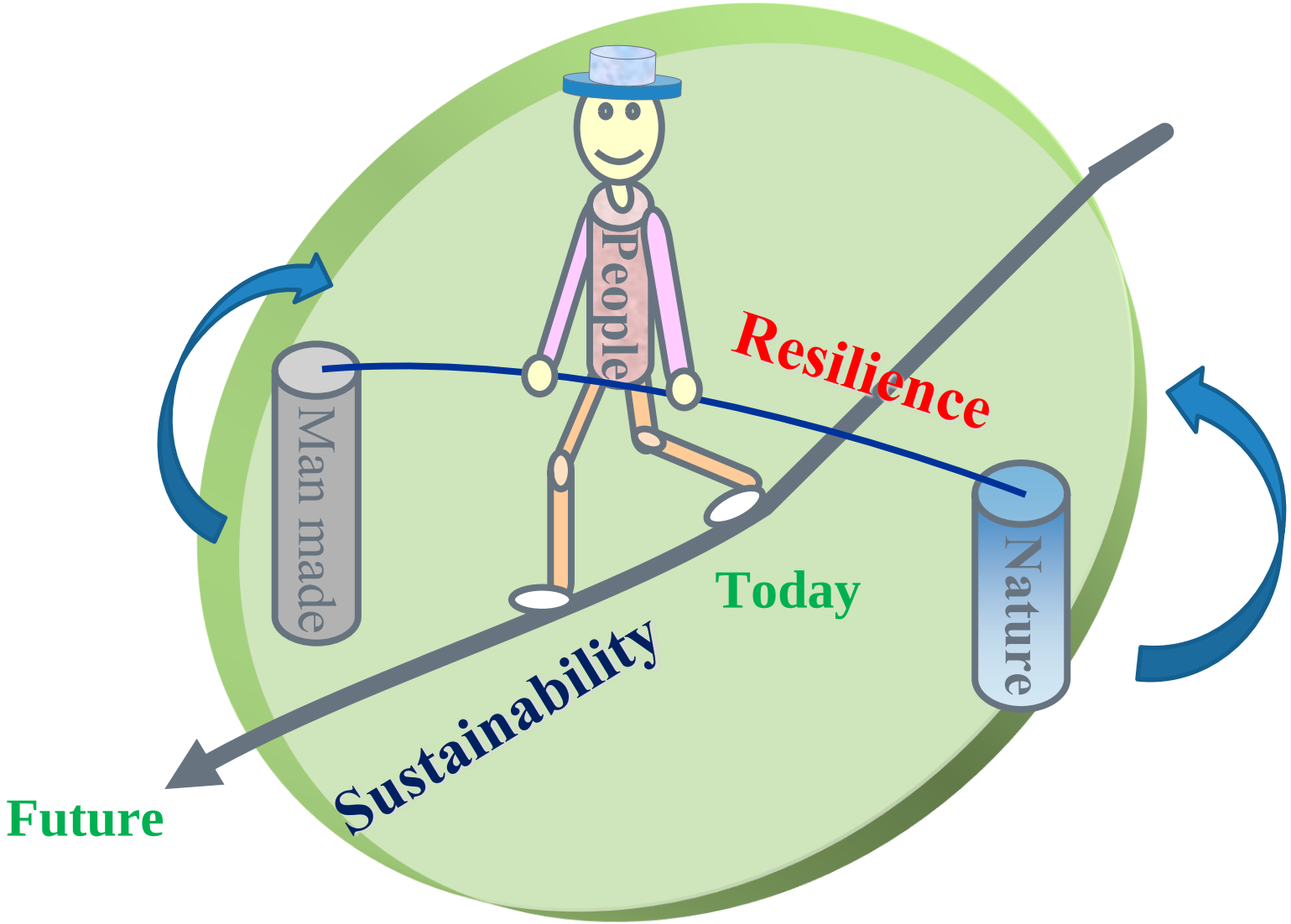
Yoshitsugu Hayashi

Distinguished Professor, Chubu University

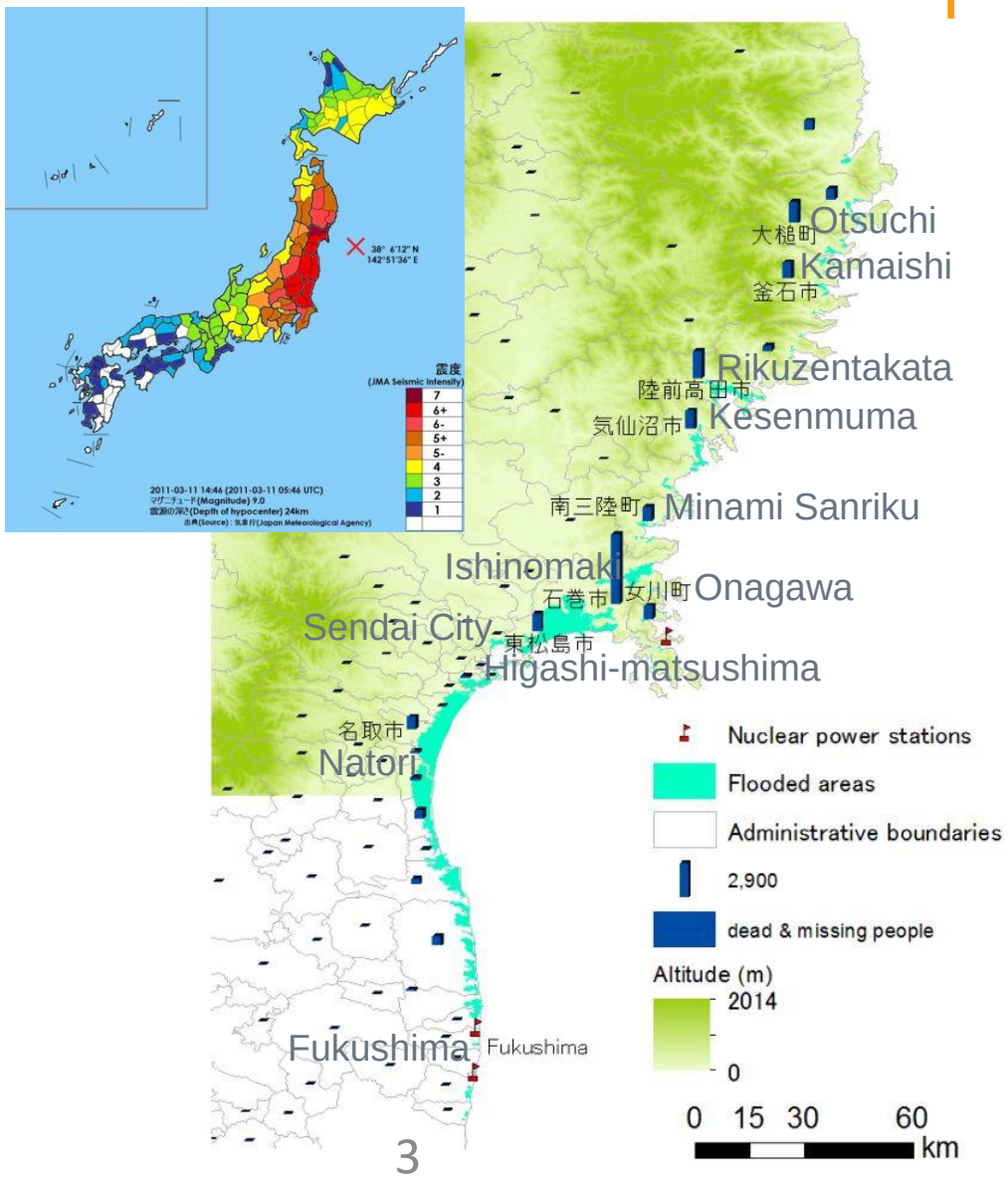
Executive Committee member, The Club of Rome

Ex President WCTRS (World Conference on Transport research Society)

Resilience as a pre-requisite to Sustainability



Damages by The Great East Japan earthquake



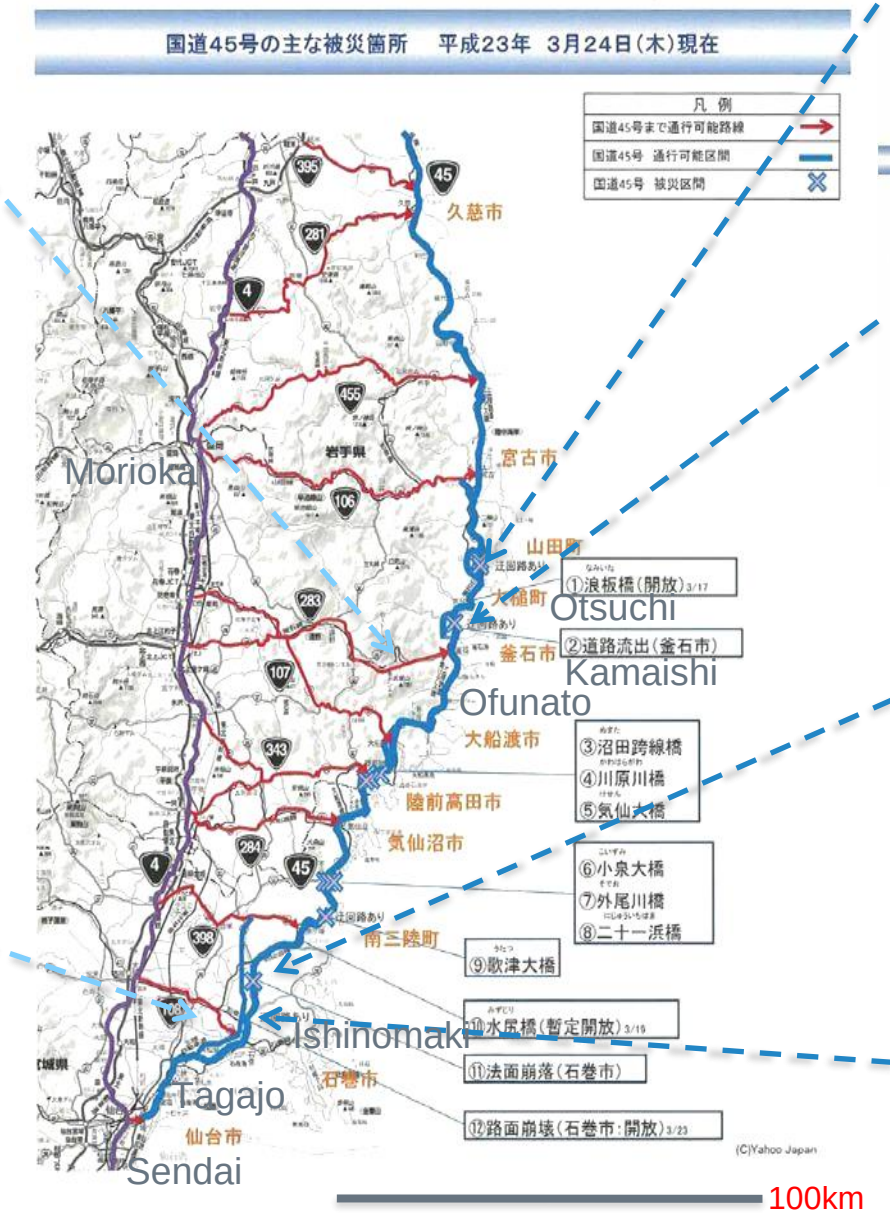
Time & Date	14:46 11/03/11
Magnitude	9.0
Earthquake type	Undersea mega-thrust
Dead	14,907 (19/05/11)
Missing	9,041
Injuries	4,799
evacuees	160,672
Tsunami area (km2)	561
Completely destroyed residential buildings	91,150

(source: Ministry of Internal Affairs and Communications, Statistics department, Japan)

Damage in Local Roads

(Coast areas lost road access)

(source: Tohoku Regional Bureau, Ministry of Land, Infrastructure, Transport and Tourism)



①国道45号　浪板(なみいた)橋（岩手県大槌町）　L=25m

②国道45号　道路流出（岩手県釜石市）

⑪国道45号　法面崩落（宮城県石巻市）

⑫国道45号　路面崩壊（宮城県石巻市）

Damage in Motorways

(Higher Spec. to recover keeping redundancy)

Closure just after the earthquake (15:50 11 March)

Crack

（3）東北自動車道 福島飯坂IC～国見IC 土工部損傷状況（3月12日撮影）
路面に亀裂と波打ちが発生。

Bump

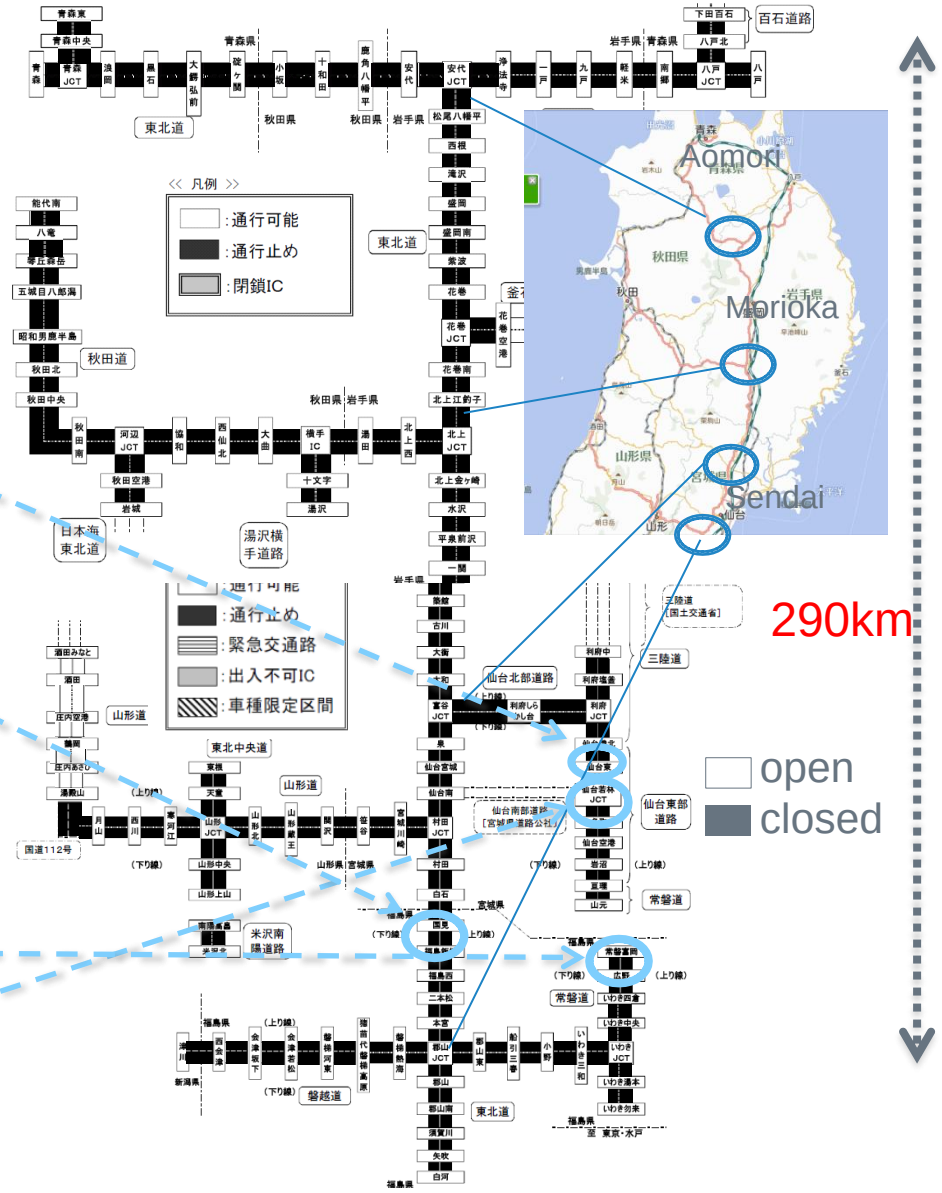
（2）仙台東部道路・仙台港北IC～仙台東IC間 橋梁ジョイント損傷状況
（3月12日撮影） 橋梁の継ぎ目部が斜めにずれて段差が発生。

Subsidence

（4） 常磐自動車道 広野IC～常磐富岡IC 土工部損傷状況（3月12日撮影）
路面に陥没による段差が発生。

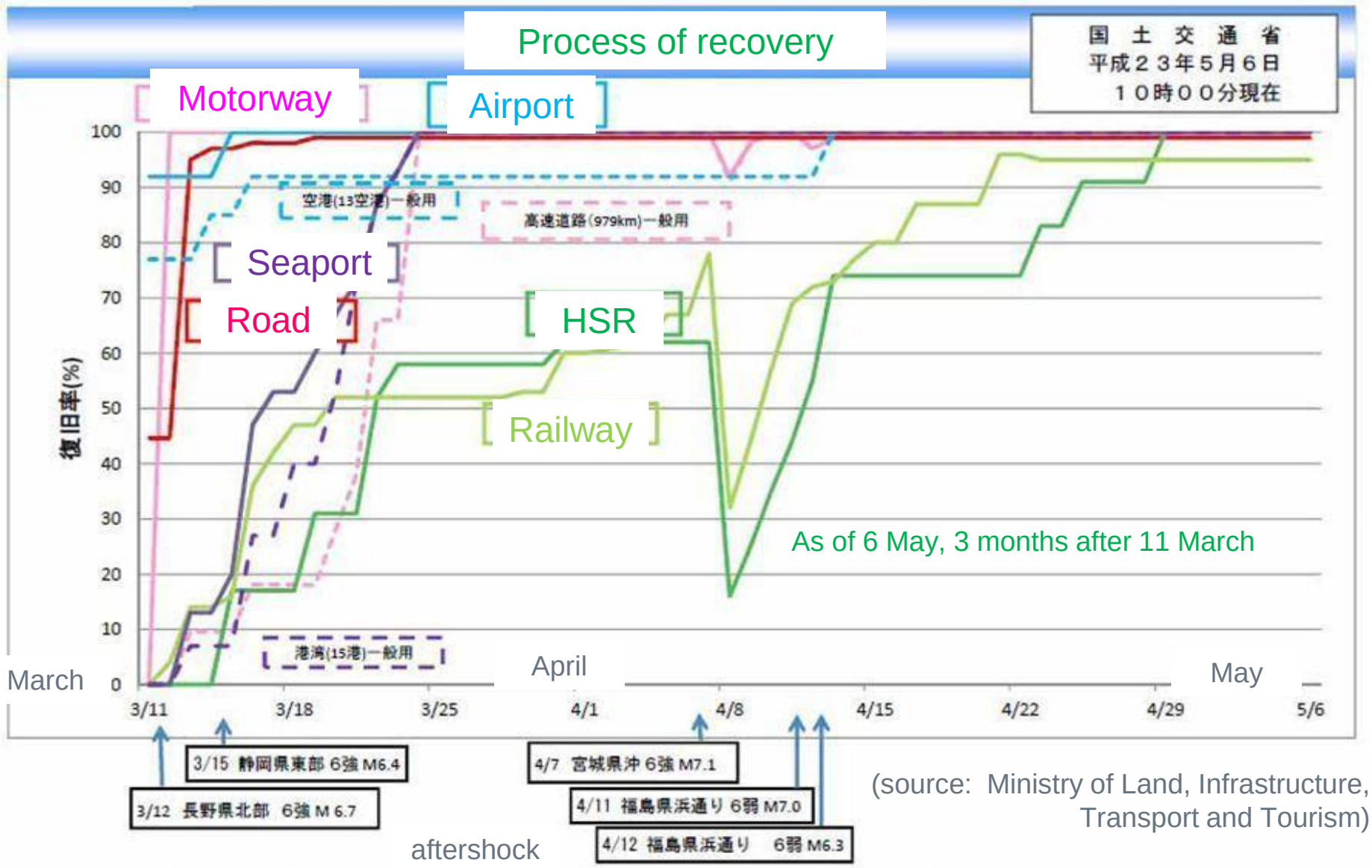
Debris

（1） 仙台東部道路・若林JCT 上下線ランプにおける被害状況（3月12日撮影）
津波によって押し流された堆積物が上下線ランプに流入。



(source: NEXCO East Japan)

Recovery in Transport

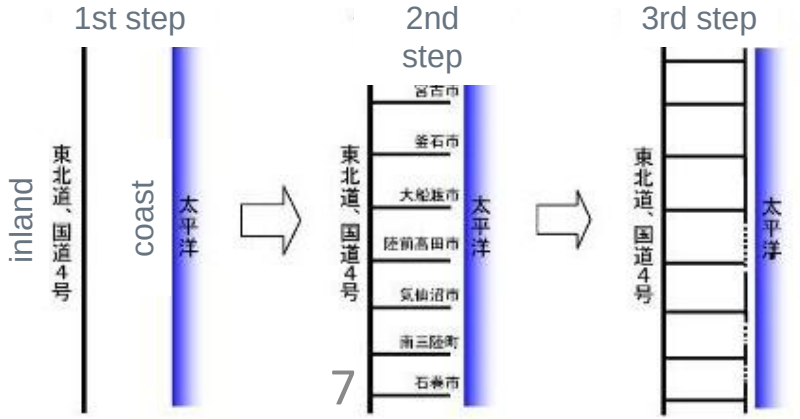


(source: Ministry of Land, Infrastructure, Transport and Tourism)

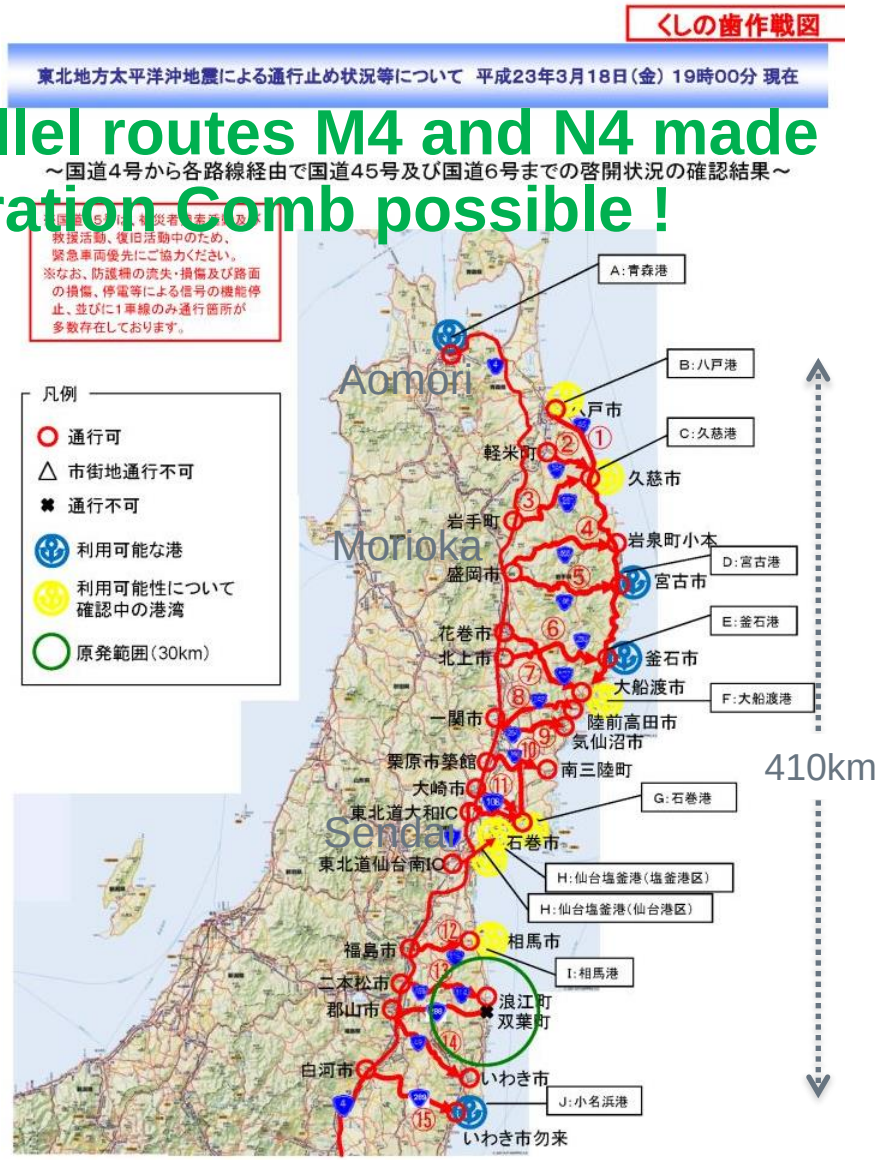
Recovery in Local Roads ("Operation Comb")

Clear debris from roads to secure access from inlands to seaports

12 March: 11 east-west routes open
15 March: 15 east-west routes open
16 March: Access open to public
18 March: Most coast roads open



Parallel routes M4 and N4 made Operation Comb possible !



(source: Ministry of Land, Infrastructure, Transport and Tourism)

Damage in Airports

Serious damage only at Sendai Airport (Flooded by TSUNAMI)

Sendai airport

Protecting huge site is difficult.

(source: Ministry of Land, Infrastructure, Transport and Tourism, Miyagi Prefectural

Damage in Seaports

Most seaports closed just after the earthquake

Ishinomaki-port

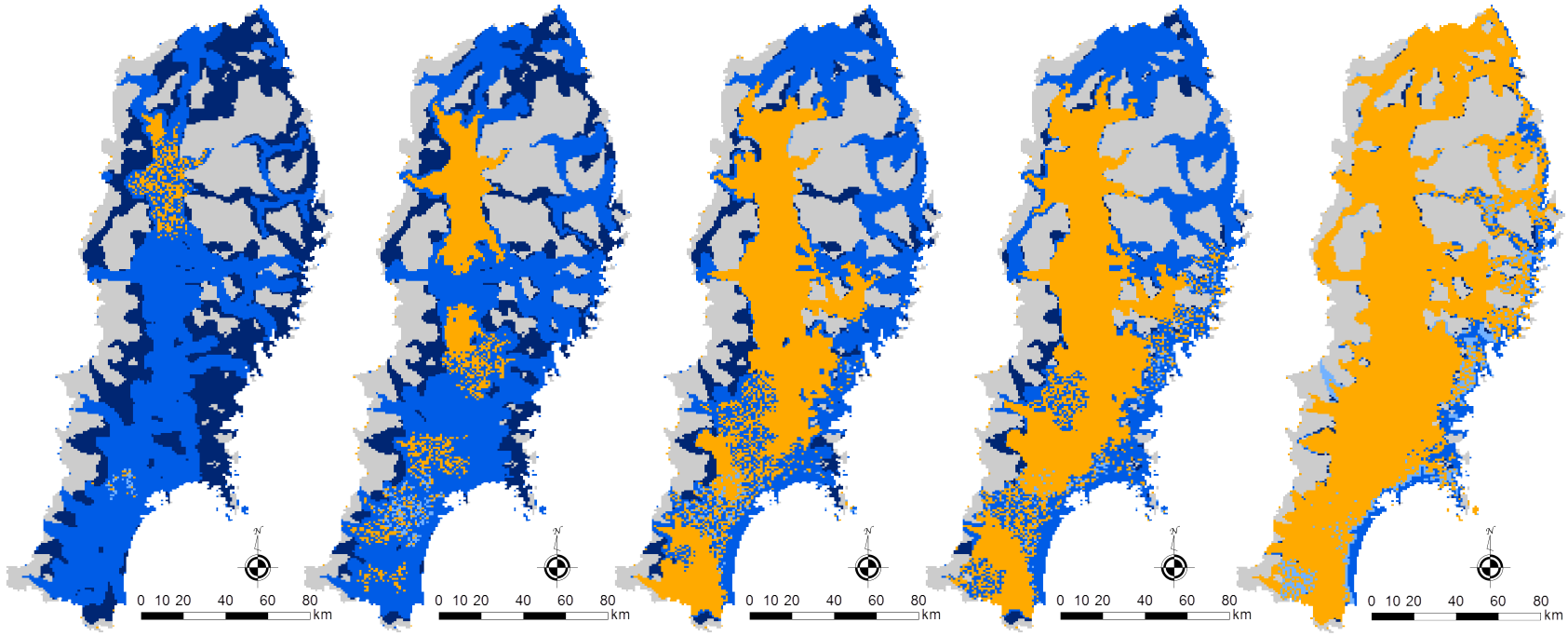
Kamaishi-port (Broken seawalls)

Sendai Shiogama-port

- Untied Containers floated to hit houses
- Oil Tanks floated to fire

(source: Ministry of Land, Infrastructure, Transport and Tourism, Miyagi Prefectural Government)

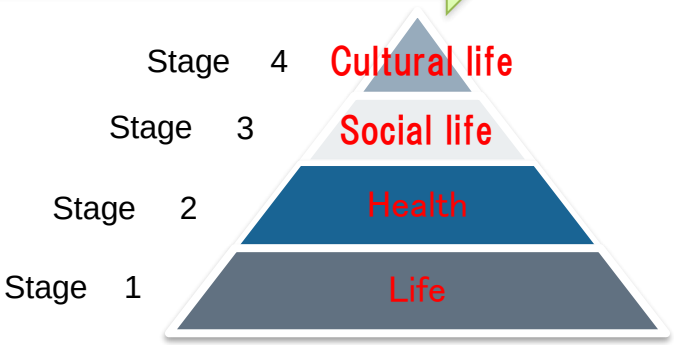
Resilience: QOL Transition after Earthquake



3/14（被災3日後） 3/18（7日後） 3/31（20日後） 4/11（1ヶ月後） 5/11（2ヶ月後）

・QOL indices are recovered from coast towards inner areas, after roads and facilities were re-open

・Areas of QOL stage 2 are bigger than flooding areas from tsunami at 3/31 and 4/11



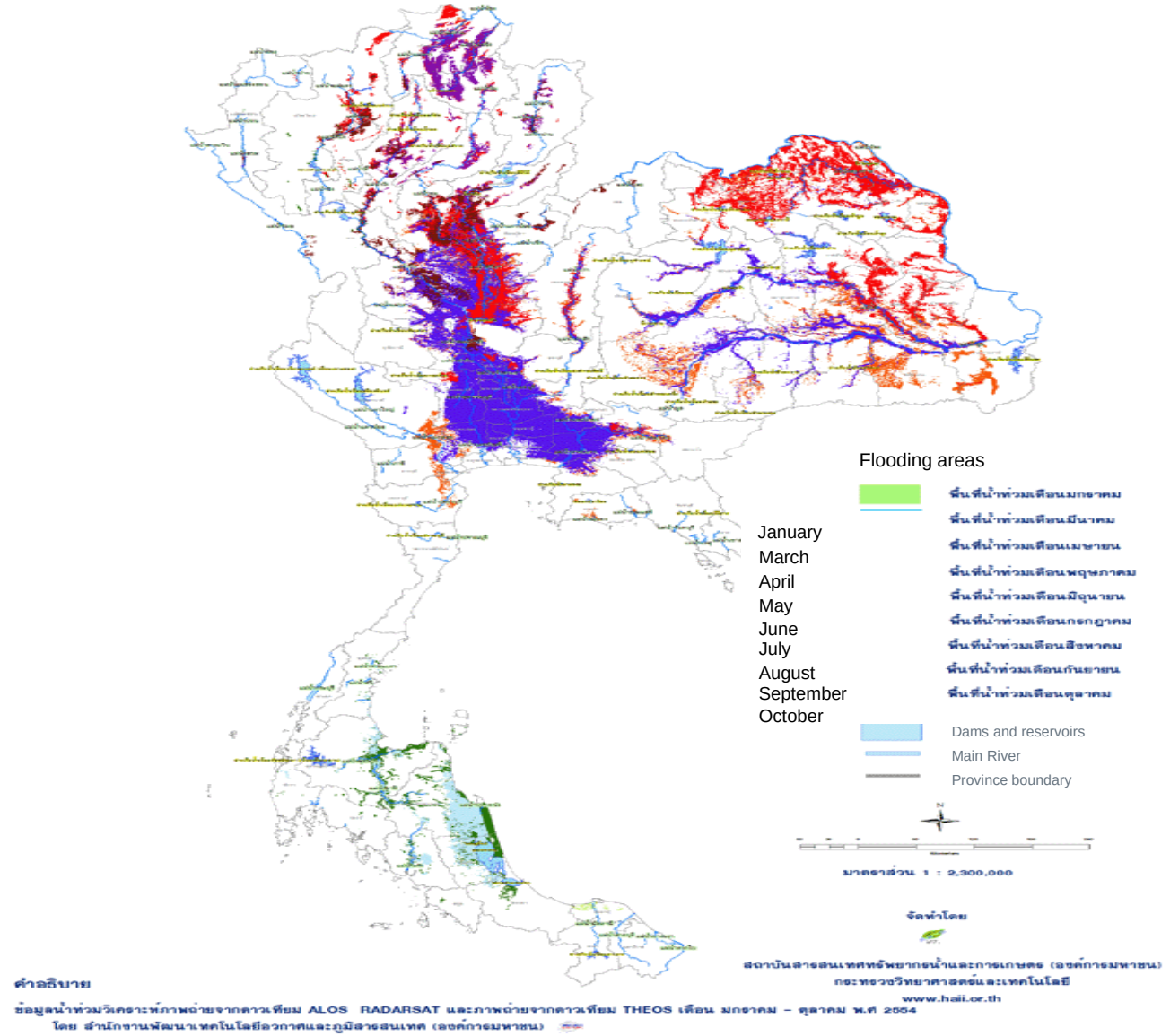
Lessons learned:

Infrastructure Supply is not enough

→ Demand-side Management

- **Mobility as a Service (MaaS)**
  - Emerging transport solution serving a package of mobility to people to enhance travel experience.
  - Promote the **shift** of mode from **private** to **public** transport
- Po

Thailand Flood
Jan-Oct 2011



By Courtesy of Dr Varameth

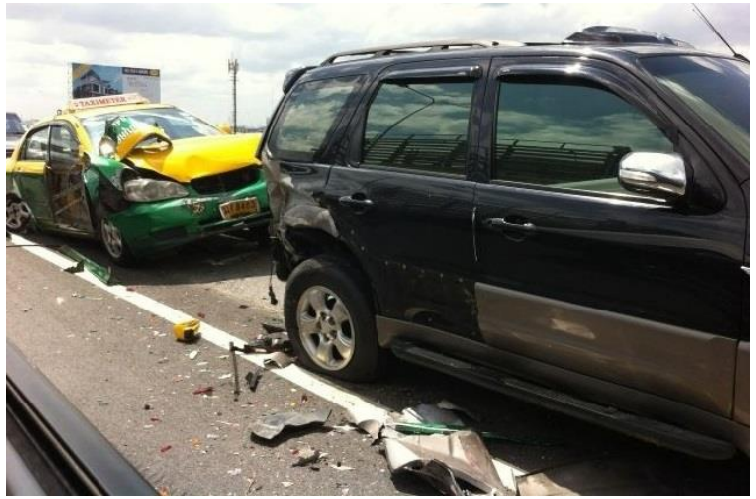
Central Region Inundated for Months

By Courtesy of Dr Varameth

Industries gone…

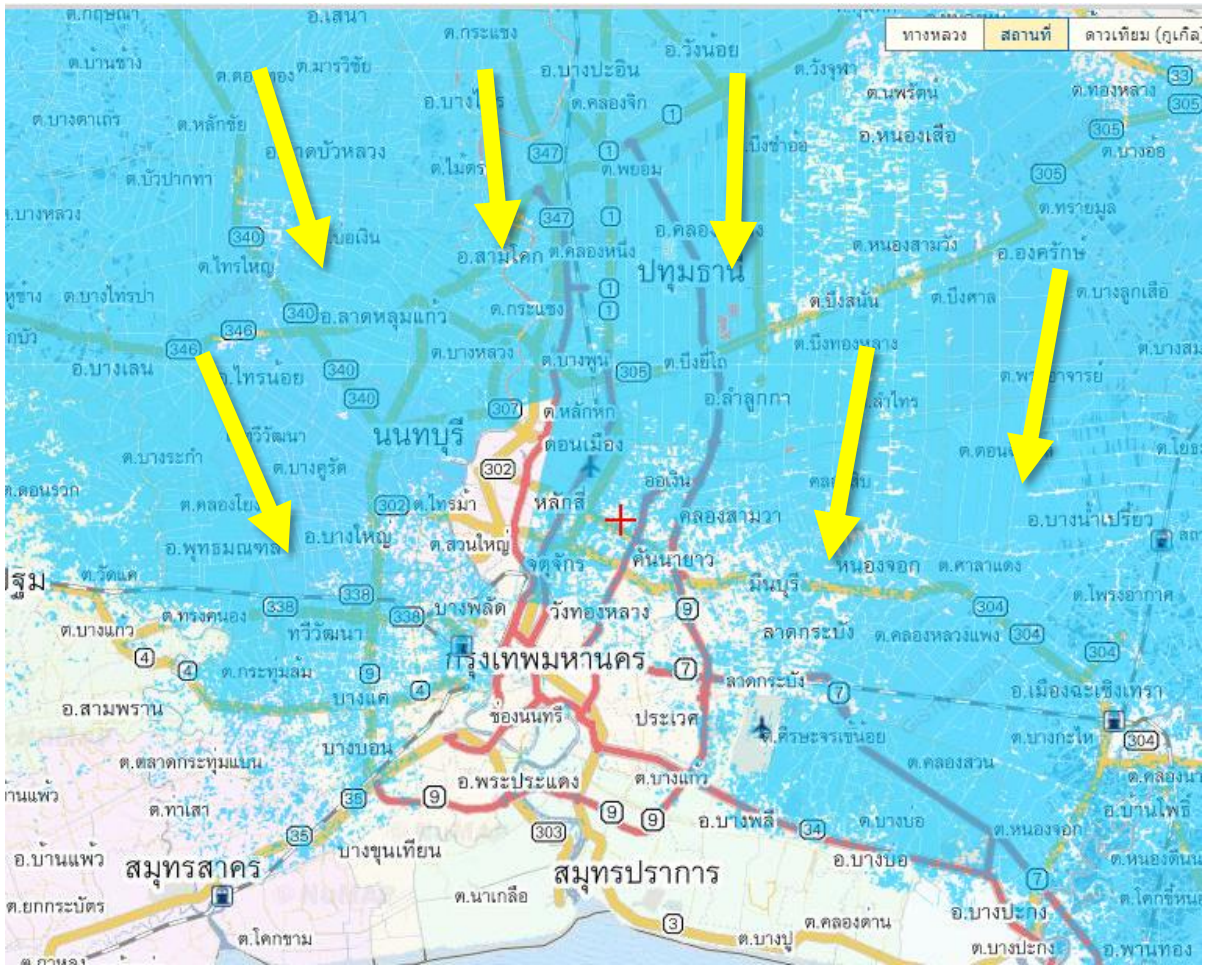
By Courtesy of Dr Varameth

On the Public Road …



By Courtesy of Dr Varameth

Central Bangkok Protected



By Courtesy of Dr Varameth

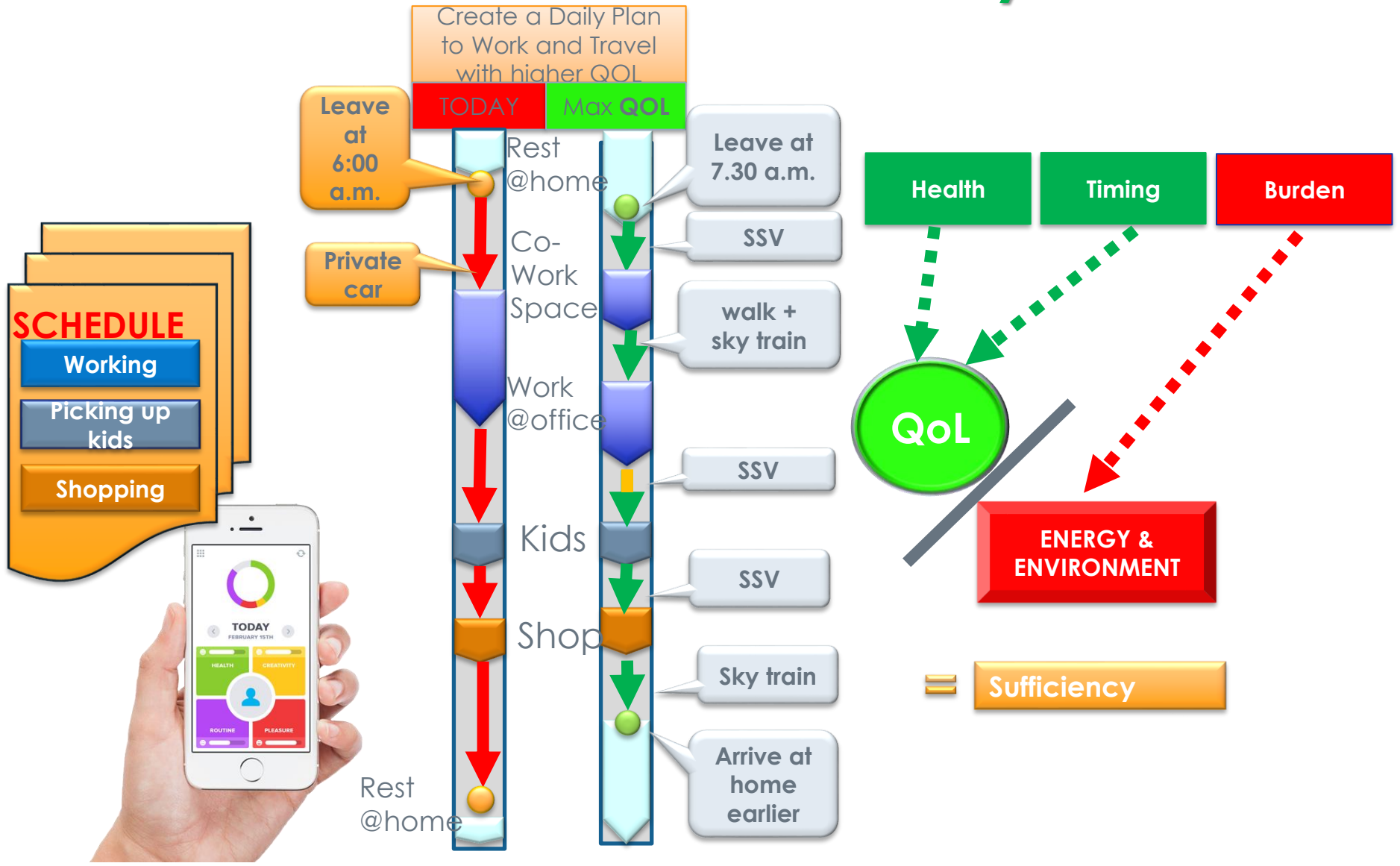
Rail+Bus: Public Transport the Only Way

By Courtesy of Dr Varameth

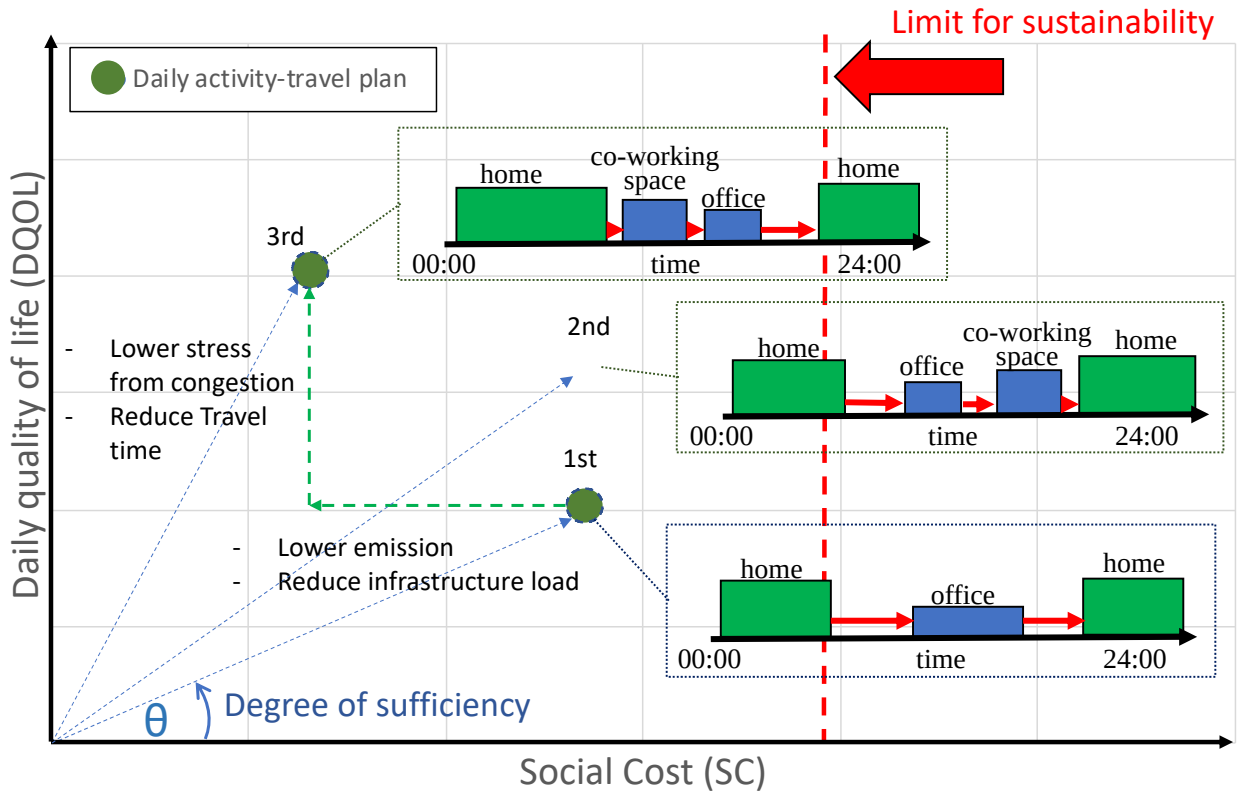
Lessons : Infrastructure Supply is not enough → Demand-side Management

- **Mobility as a Service (MaaS)**
  - Emerging transport solution serving a package of mobility to people to enhance travel experience.
  - Promote the **shift** of mode from **private** to **public** transport

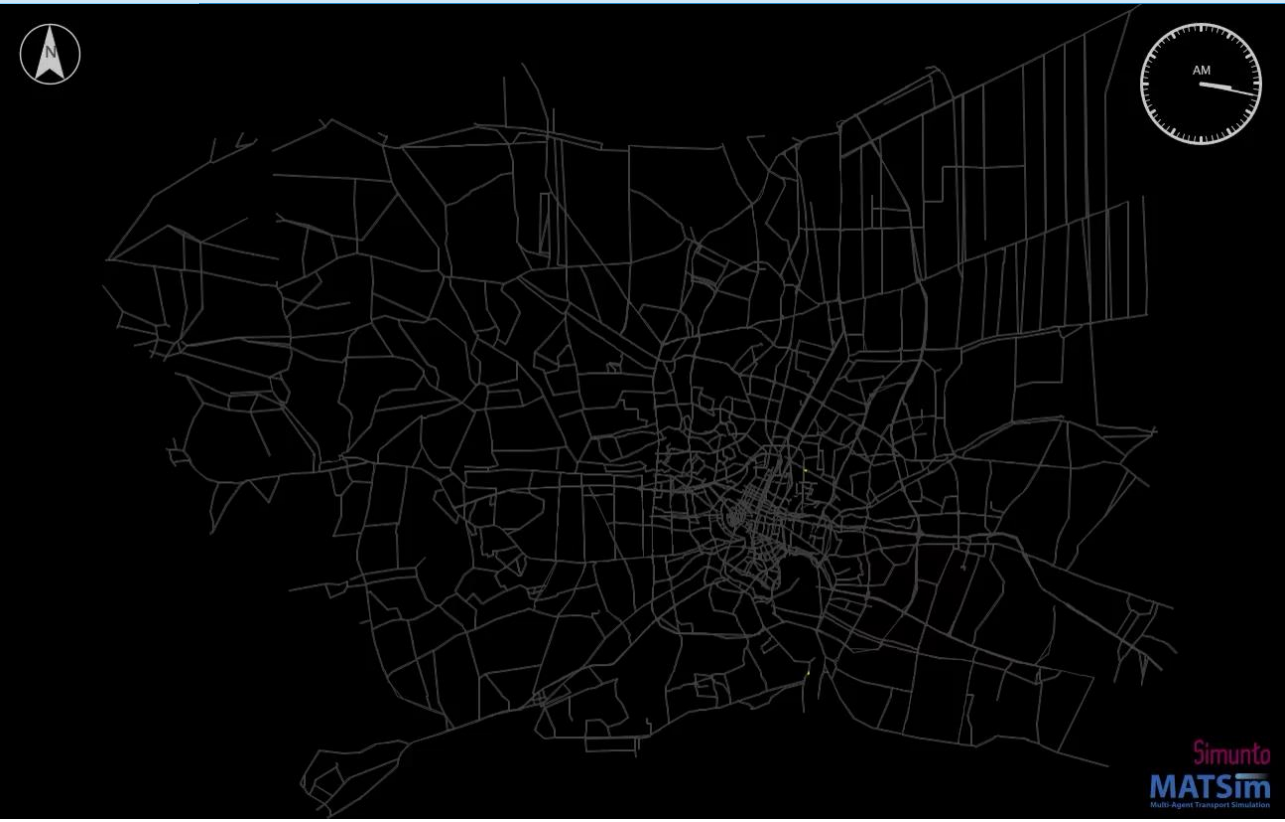
Sukhumvit Model – QOL - MaaS: Daily Life-Travel Design

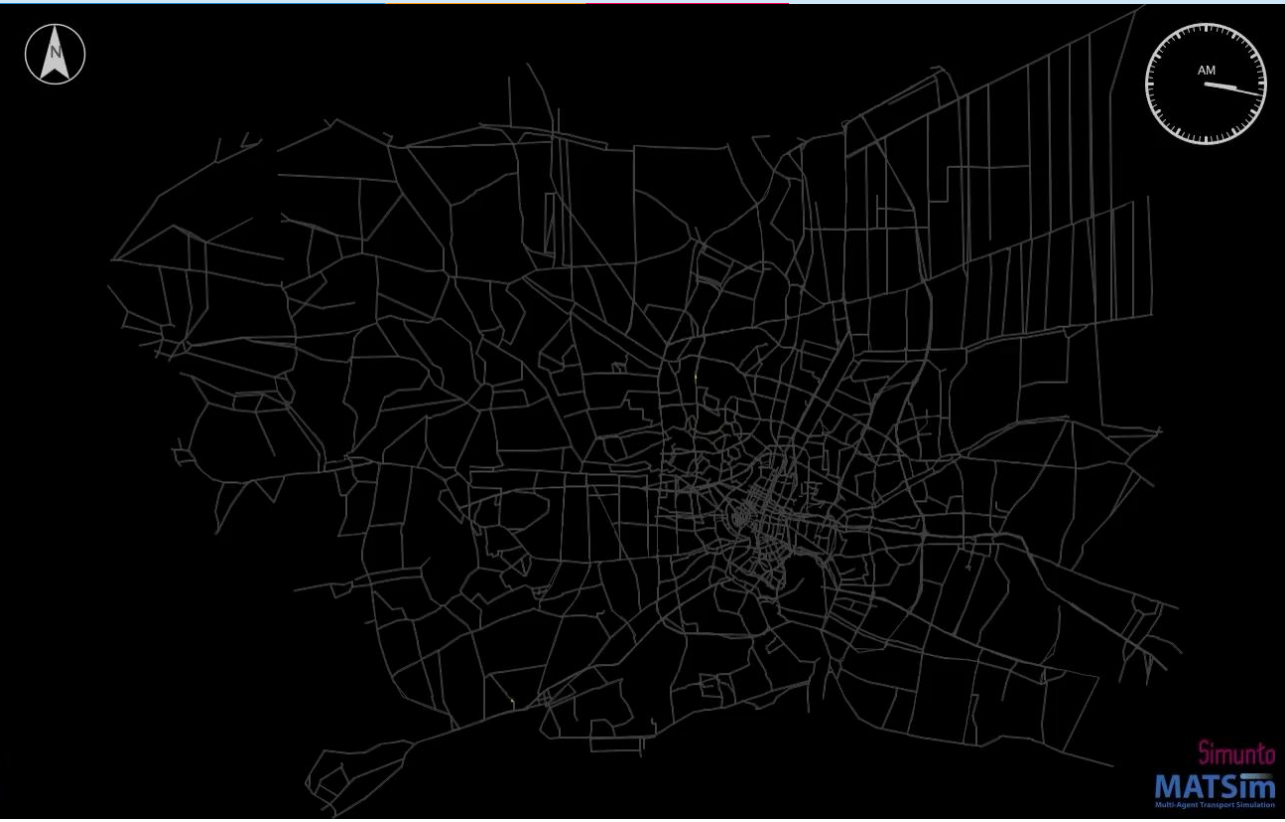


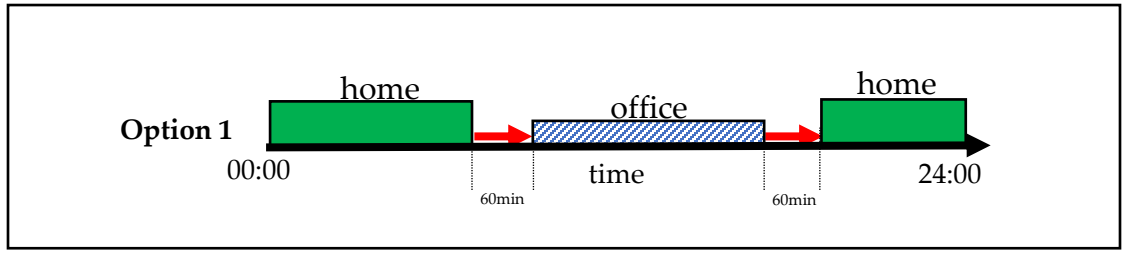
QOL-MaaS recommends Most Sufficient Sequence of Activities and Travels



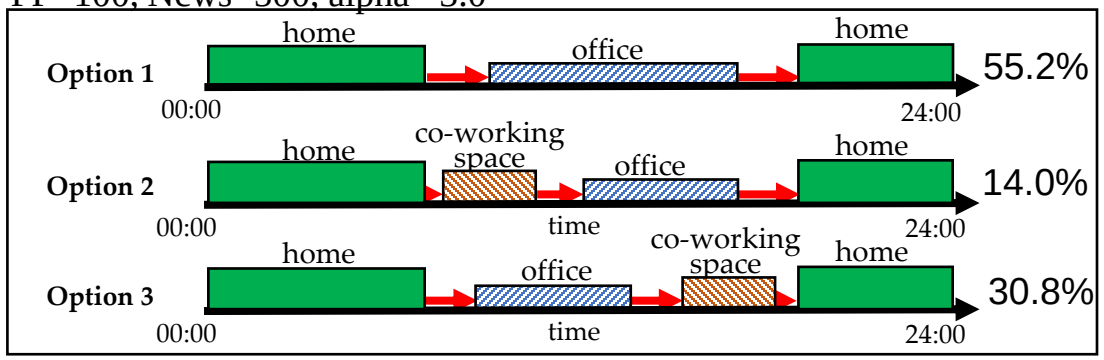
Simulation results







FP=100, Ncws=500, alpha= 3.0



Lessons learned: land use & transport perspectives

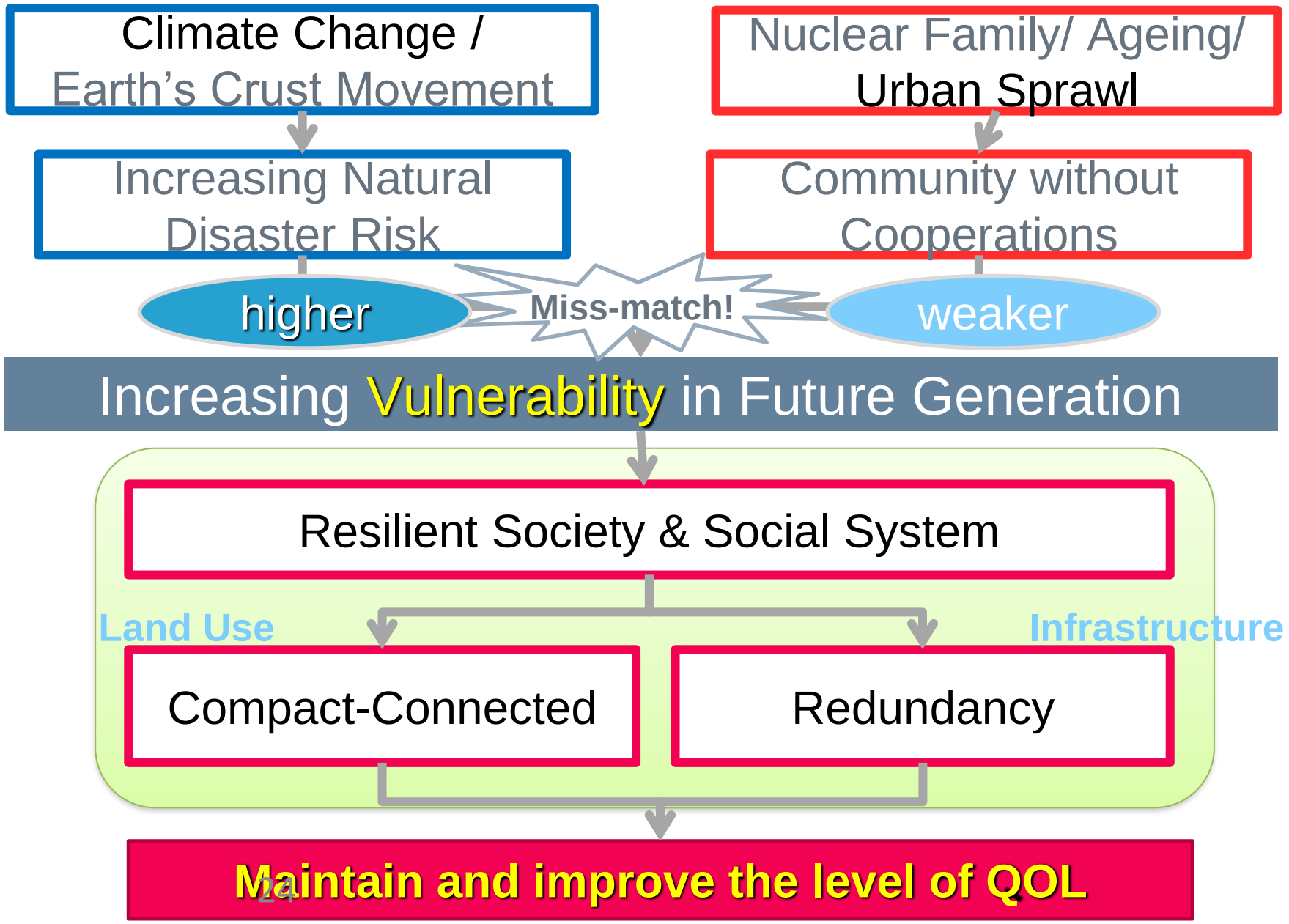
by Varameth Vichiensan

- The poor land use regulation caused urbanization into very large area, which used to be flood plain. These urbanized area were obstructing the surface water. The flooding water needed to be drained into canals and rivers having limited capacity. This caused the flooding more rapid and severe. So, the **regional and urban land use plan and enforcement** must be revisited.
- In the past, the canals were large and could drain the flood water. But now most of the canals were filled with houses and factories. Canal drainage were then replaced by pipe drainage system. However, since land subsidence is large in Bangkok and other cities. The pipes were not functioning well. More effective urban drainage system must be redeveloped. **The future urban land use forecast** will be very important information.

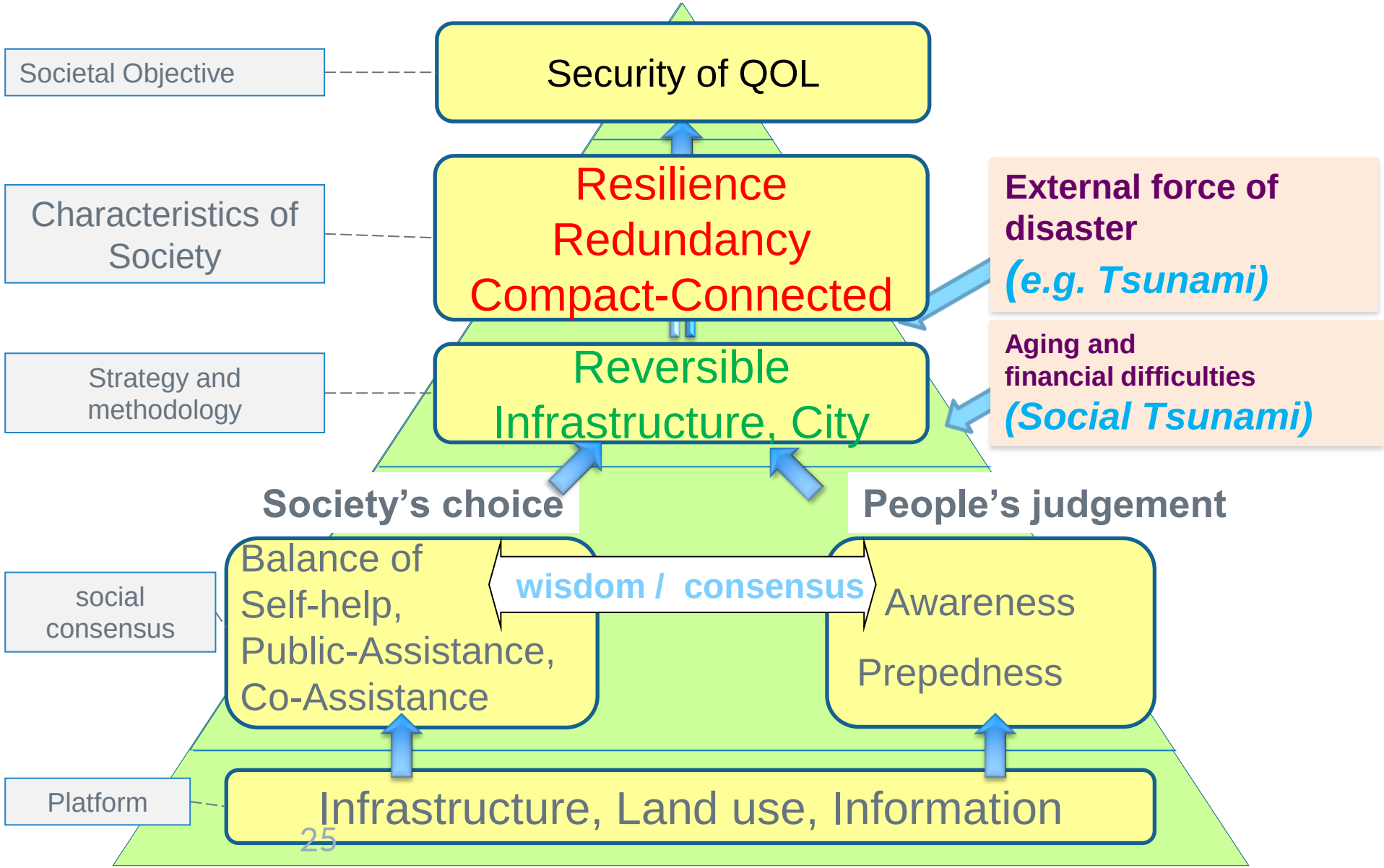
Lessons learned: land use & transport perspectives (2)

- The transport network in Thailand was not planned to handle such situation. Most of the roads were cut, leaving many municipalities isolated. Production and logistic were enormously affected, causing shortage of food and daily life supplies. Therefore, **a strategic transport network plan** is needed, particularly highway, such that certain routes must be protected for logistics during emergency, not only flooding but also other kinds of disaster.
- During the flooding, **cooperation of the road and public transport operators** will have important roles to lessen the impact. For example, exemption of toll collection might help to divert the inundated road on to the elevated expressway and relieve the congestion. These operations might need proper support or subsidy from the local or central government.

Changes in *Nature* and *Social Acceptability*



Resilient Cities and Community



Evaluation and Planning for Resilient Cities

- Access from living place to service facilities
  - QOL Accessibility method
- Hierarchical centers and transport networks
  - 15 City (Japan, Paris), Central Place Theory(Germany)
- Demand-side Management is essential
  - Down-sized/time-space flat Equilibrium → QOL-MaaS
  - Human-Planet centered Sufficient Solution =QOL/CO2
- *Hayashi, Suzuki (2016) Disaster Resilient Cities*

Resilience as a pre-requisite to Sustainability

Thank you for your attention!