

IIASA—DPRI
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Design of In-floodplain Countermeasures to Maximize the Success Ratio of Evacuation

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Comprehensive Flood Mitigation Scheme

Mitigation

prediction
& warning

Evacuation

Education

Software-based

augmentation
etc

floodplain

Hardware-based

reservoirs
dikes
etc

River
channel

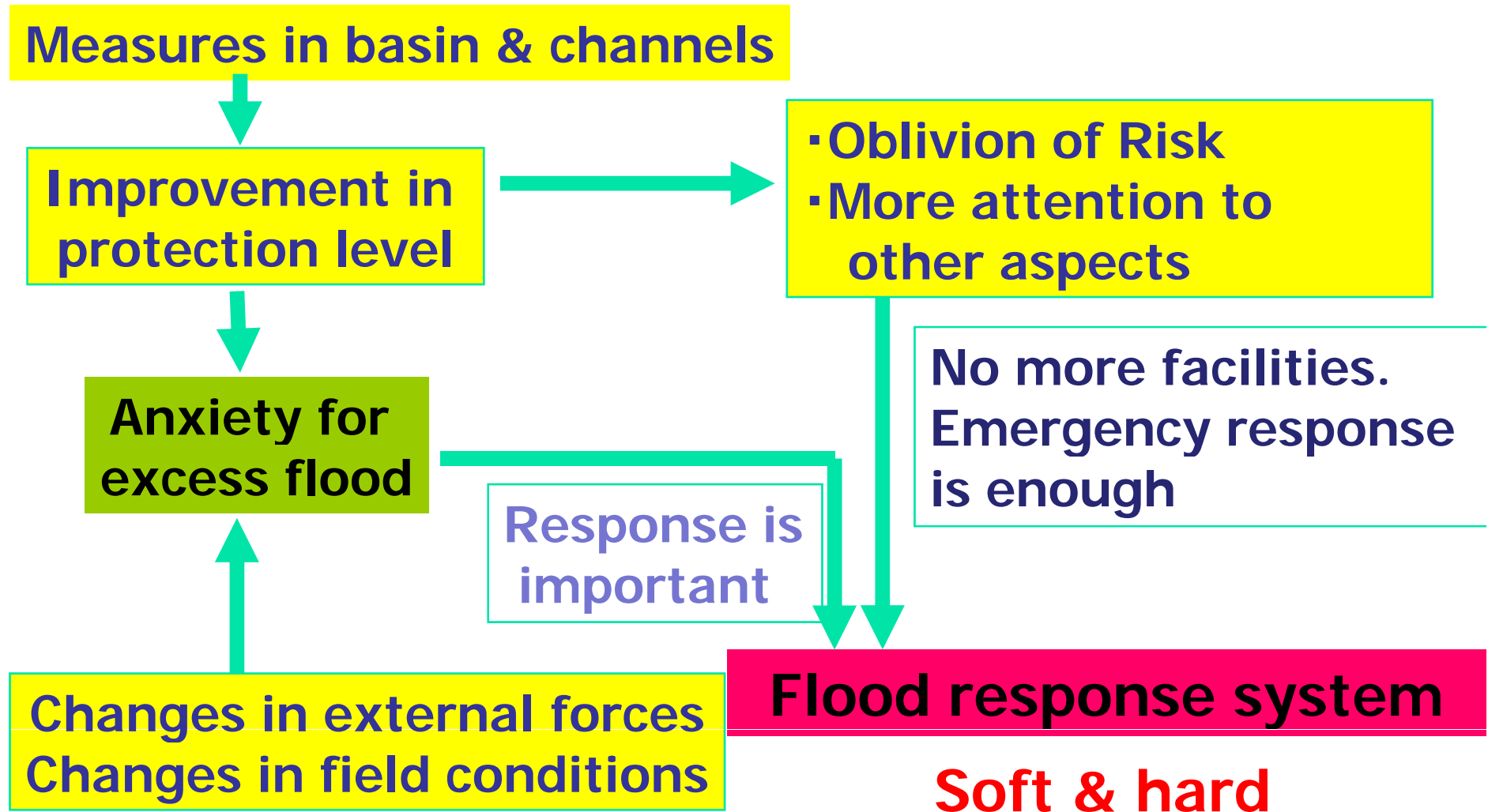
compensation

Loss assessments

Insurance

target of
this research

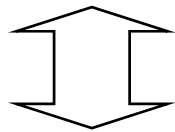
In-floodplain mitigation



Problems in System Design

Design of ordinal flood control system:

- Target: reservoirs, dikes, retarding pond, runoff reducing
- Simulation: runoff analyses, flood routing



Design of in-floodplain

- Target: flow control, augmentation, evacuation, flood fighting
- Simulation: 2D inundation analysis

High computation load
Many alternatives
Soft & hard systems

Design Formulation of Floodplain Countermeasures

$$\max_{\mathbf{x}} \int_{\mathbf{w} \in \Omega} g(\mathbf{x}, \mathbf{w}) f_{\mathbf{w}}(\mathbf{w}) d\mathbf{w}$$

subject to

$$h(\mathbf{x}) \leq h_{\max}$$

\mathbf{x} : Option vector, \mathbf{w} : uncertainty factor

$g(\mathbf{x}, \mathbf{w})$: Estimation of option \mathbf{x} ,

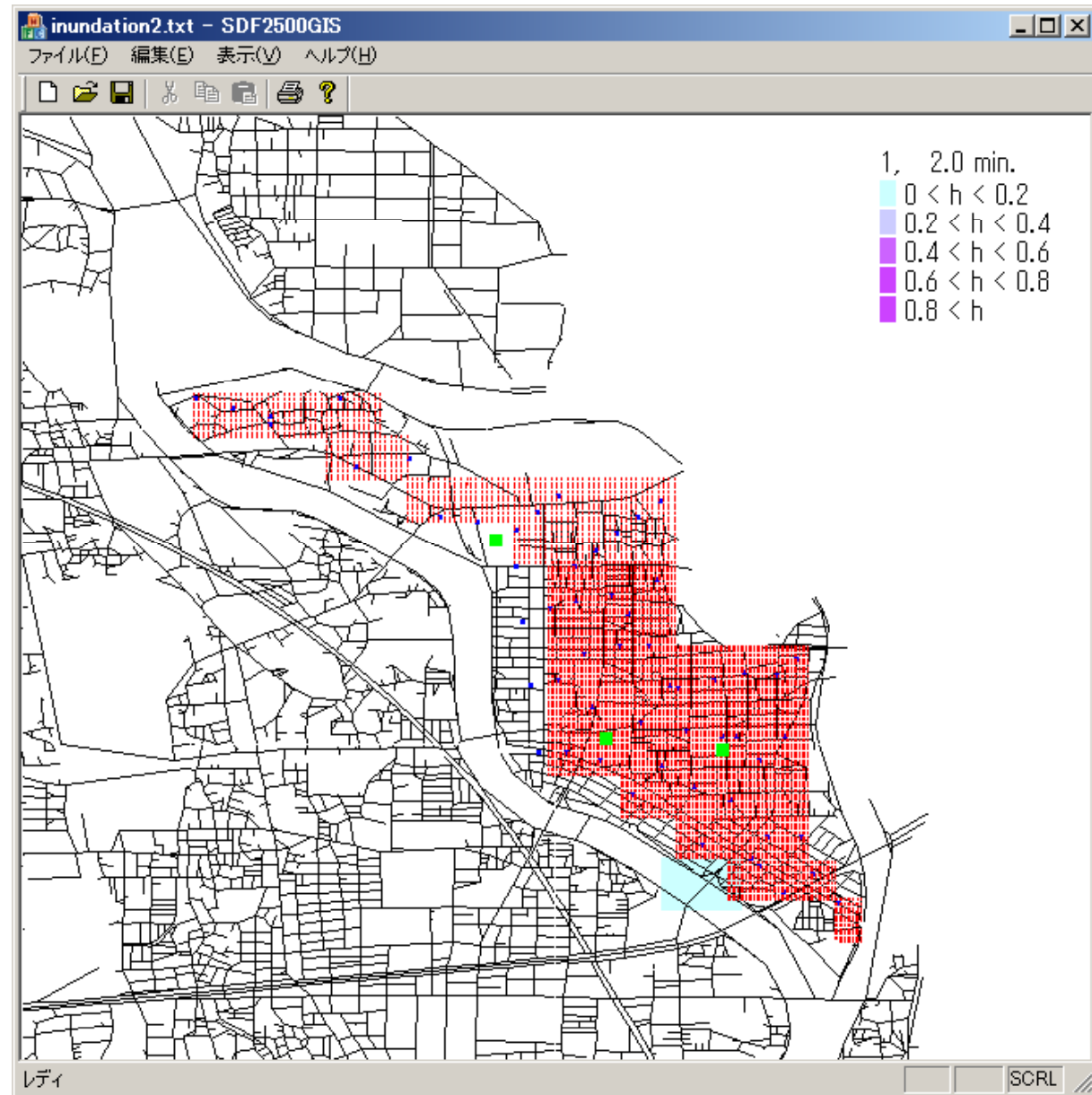
$f_{\mathbf{w}}(\mathbf{w})$: p.d.f of \mathbf{w}

Augmentation of Evacuation Route

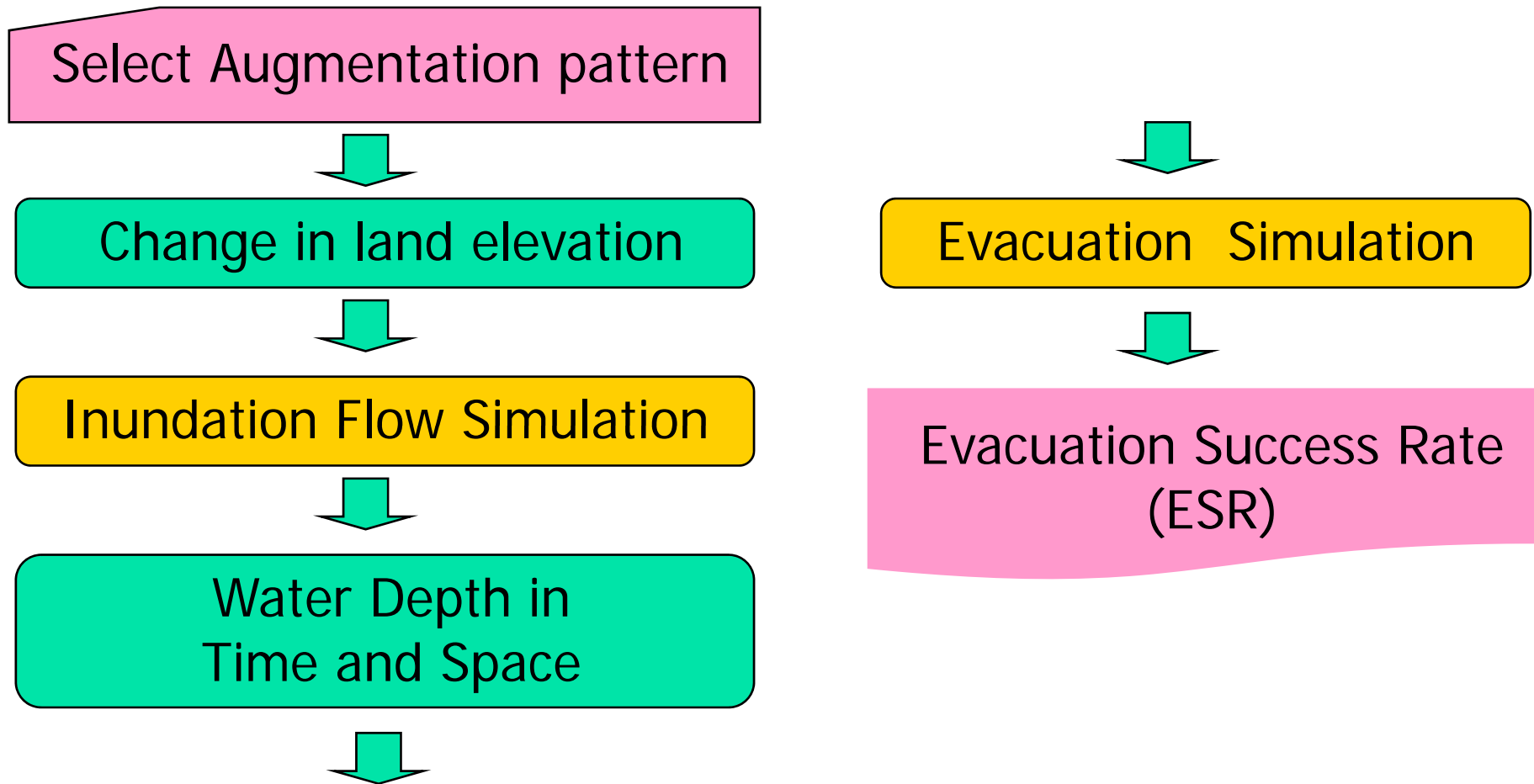
- Performance index:
Evacuation success rate (ESR) = $\frac{\text{safely evacuated}}{\text{total residents}}$
- Constraints: Total augmentation Volume
~ Cost
- Success in Evacuation: to reach pre-defined place safely within limited time
- Evacuation: speed changes according to water depth

Maximize ESR subject to given total augmentation volume

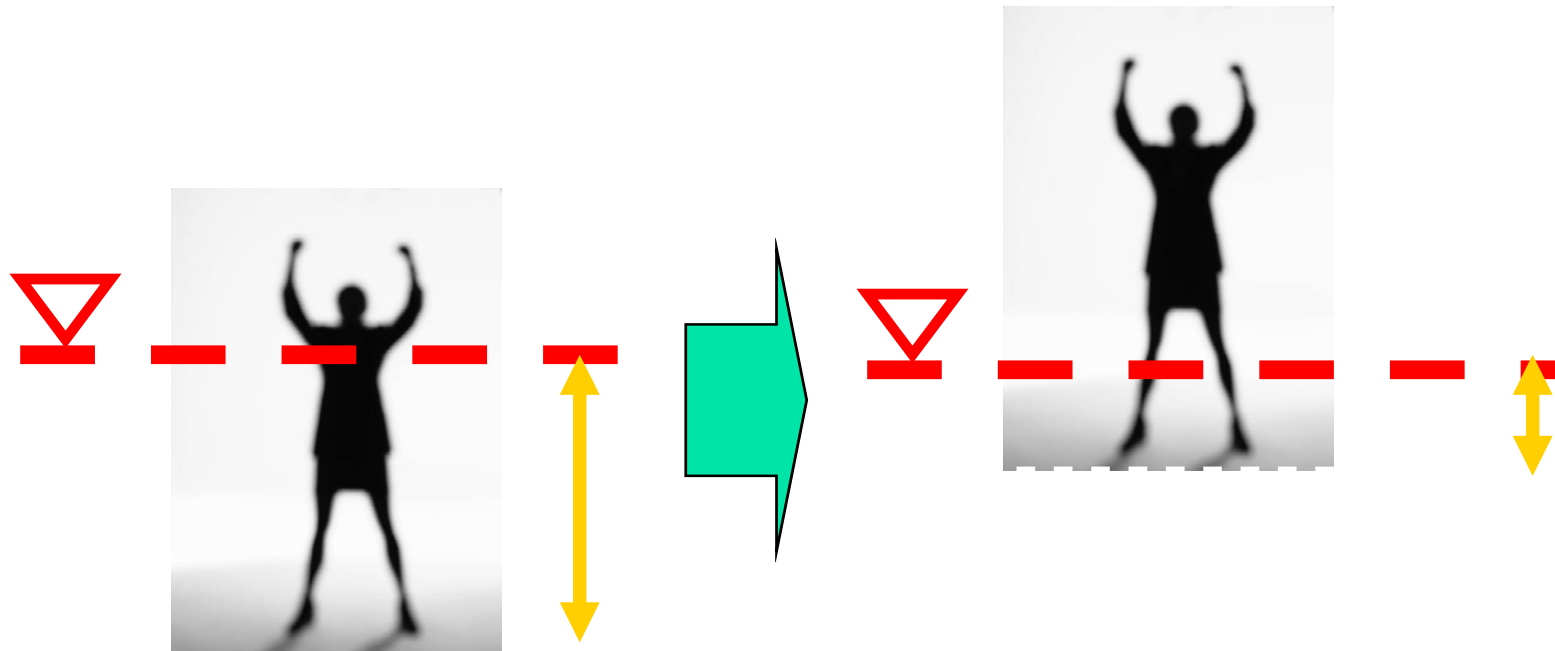
Evacuation
Simulation
From Flood
hazards



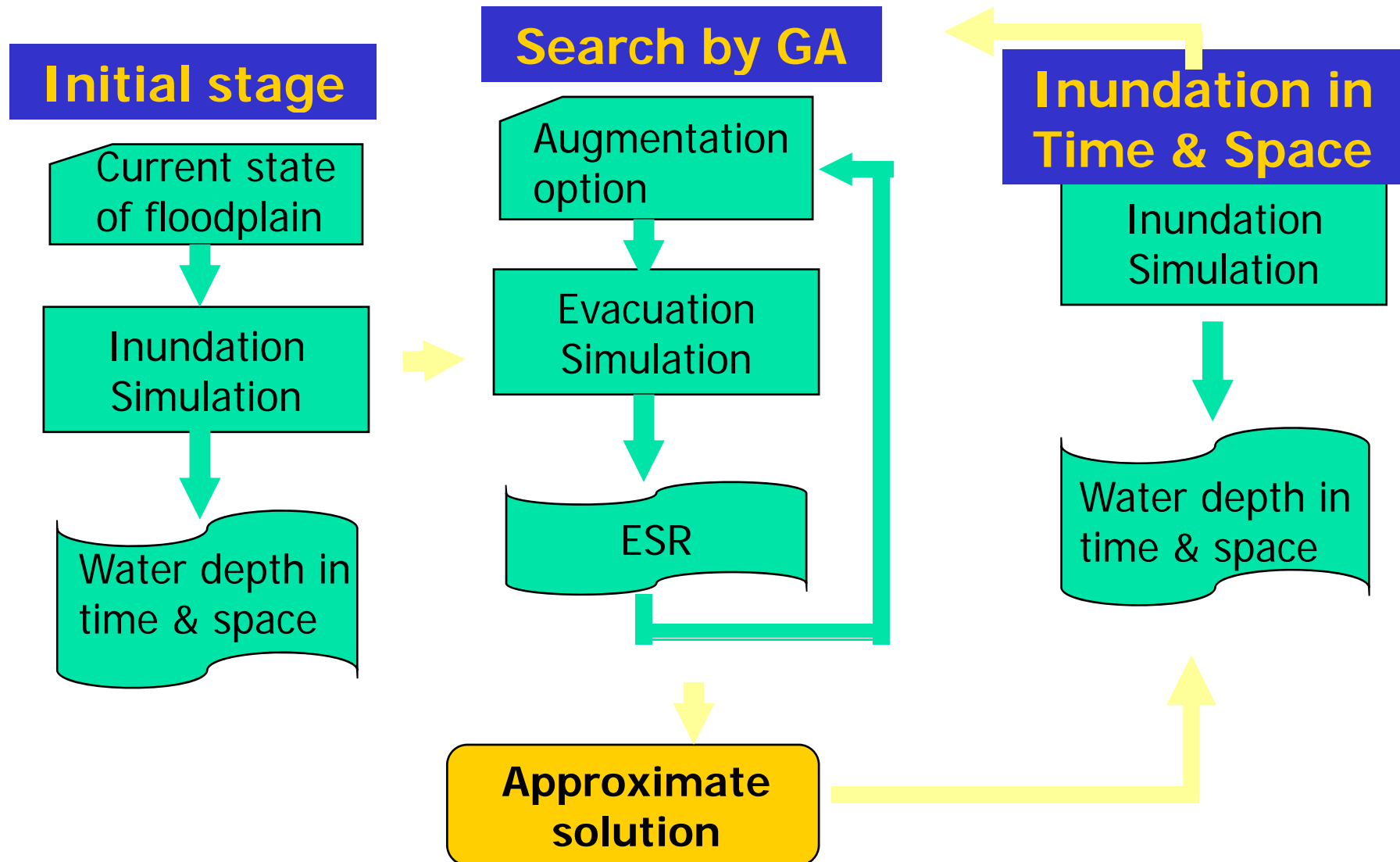
Computational Process of Evacuation Success Rate



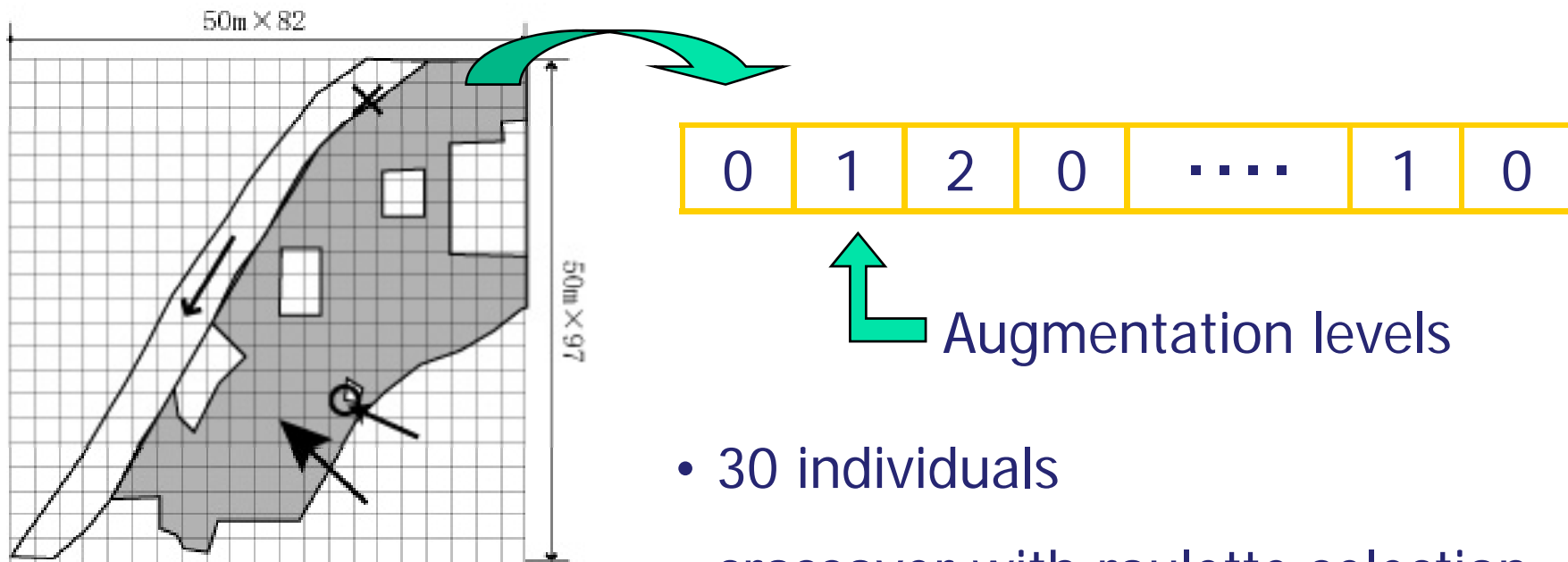
Approximation of the effect of land augmentation



Solution Search Algorithm

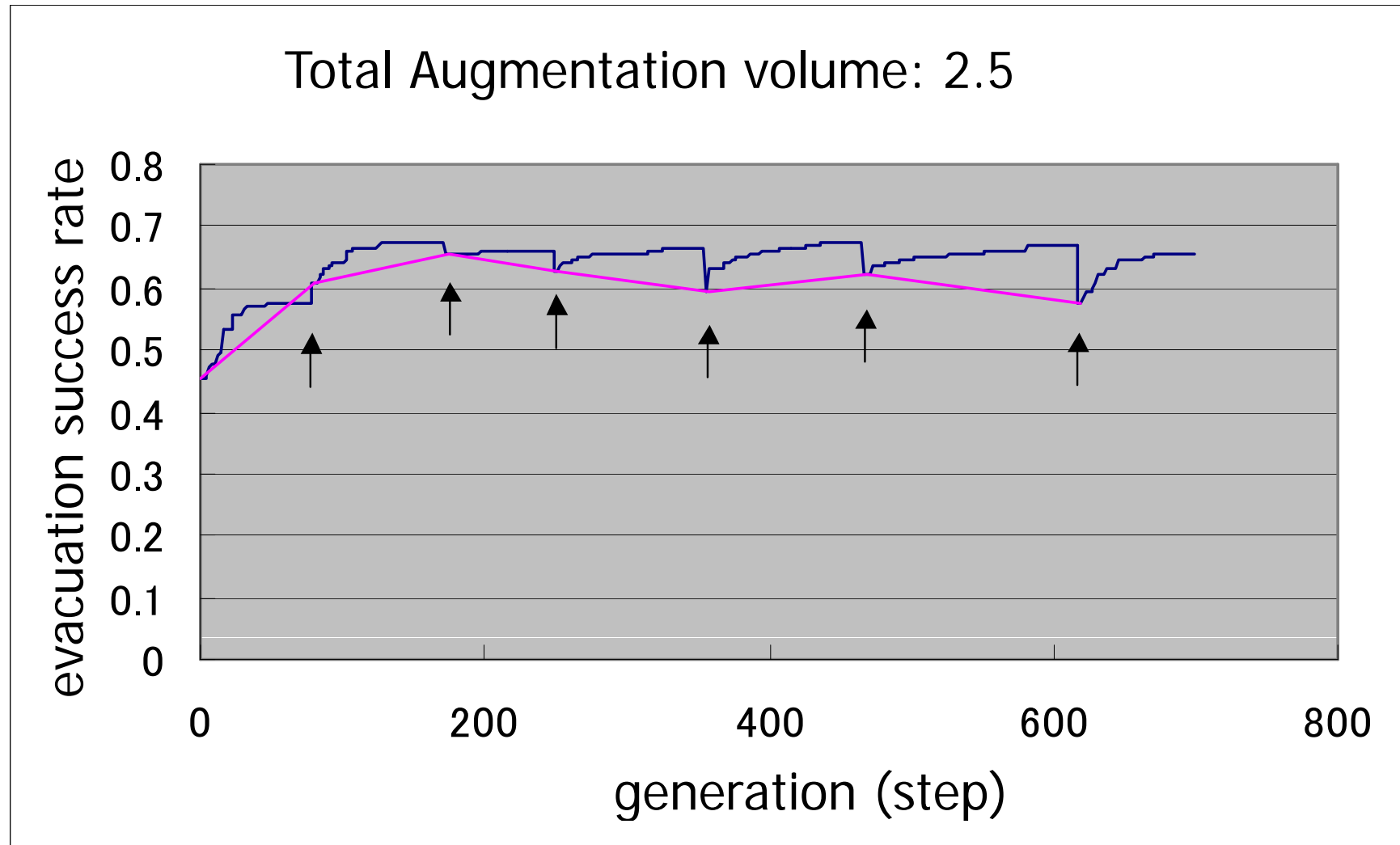


Approximate search by GA

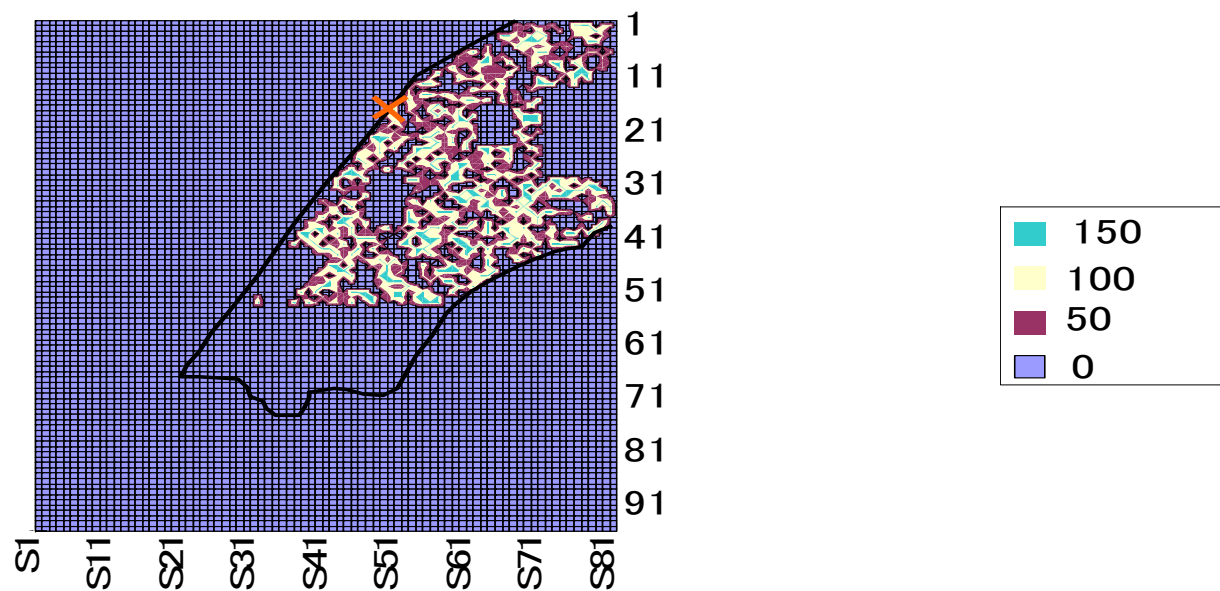


- 30 individuals
- crossover with roulette selection
- Elite preservation

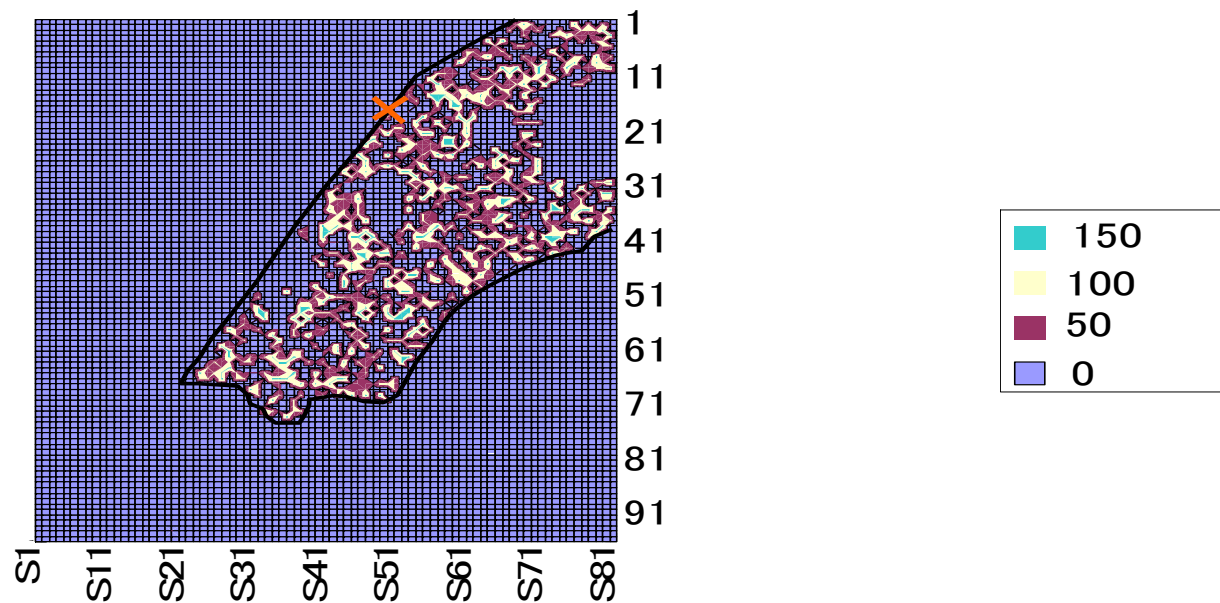
Typical Search Process



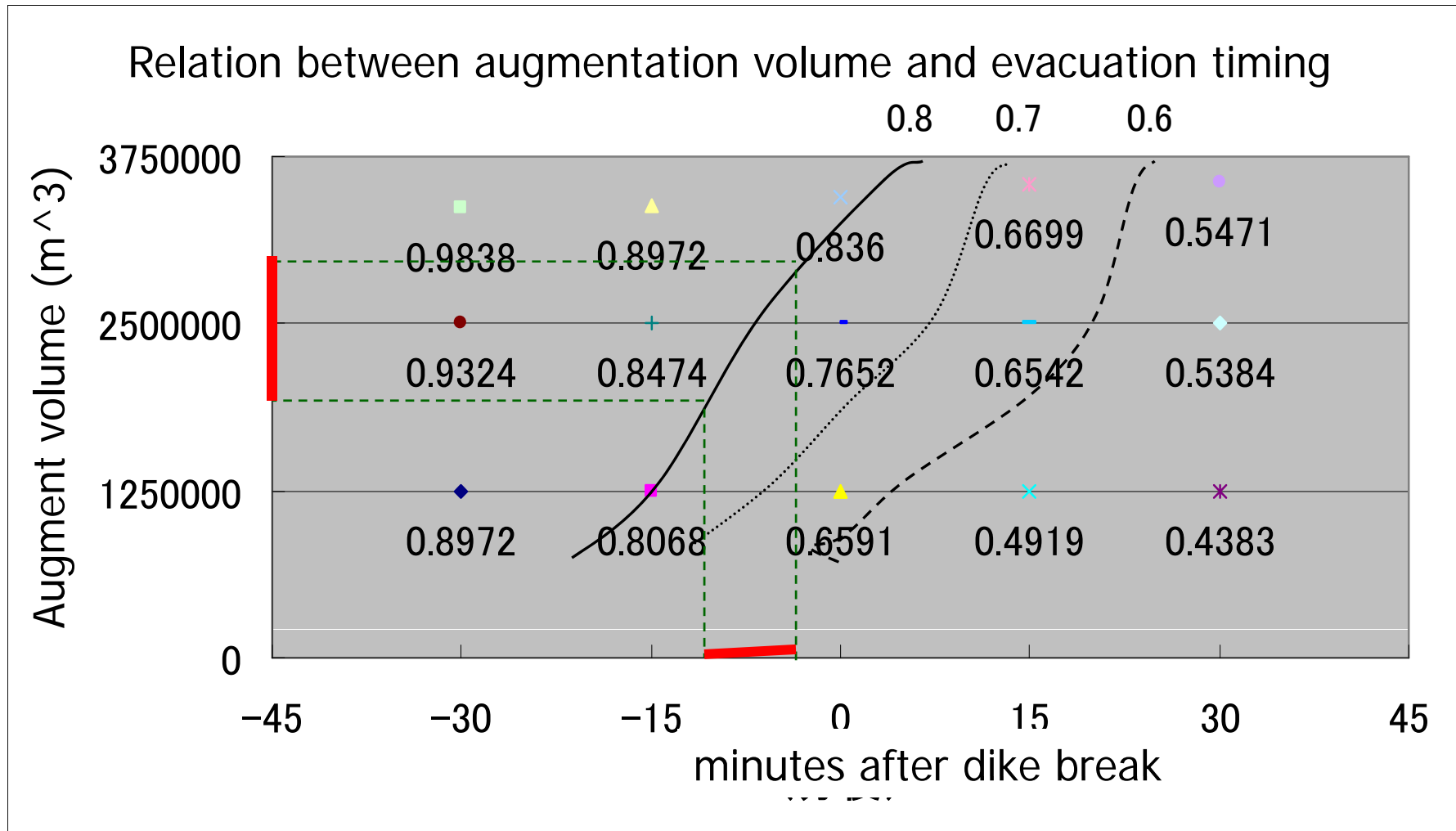
嵩上げ量250万 m^3 :破堤0分後避難



嵩上げ量250万 m^3 :破堤0分後避難



Complementarity between hardware- and software-based countermeasures



Conlusions

- Two-layered optimization scheme considerably reduces the computational burden in the optimization process of in-city countermeasures against inundation.
- Complementary between hardware- and software-based countermeasures can be estimated quantitatively, which will be important information to negotiation process among authorities and residents.