FORUM 8
3D Visual Interactive Simulation Specialists

VR-design Studio™

VR-Design Studio Tsunami Plug-in

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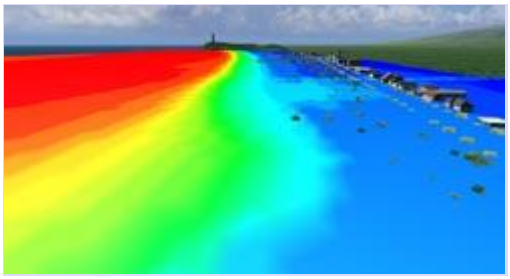
Product details

Program Overview

This is a universal plug-in which enables VR-Design Studio users to reproduce and visualize as an interactive 3D VR real-time environment various simulation results such as the tsunami analysis code developed by a Japanese universities and research institutions as well as commercial tsunami analysis programs.

- Data of any form can be visualized by converting its format into the FORUM8 open format
- The ability to visualize flood propagation by importing the terrain mesh data used for analysis and the ability to create the terrain patch from this mesh
- Colour contours or the reflection of water surface can be selected as a means of visualization
- Results of a large scale analysis can now be applied. Simulation in long stretches is possible by reducing the memory consumption at the time of performing an animation.



Demonstration of contour expression

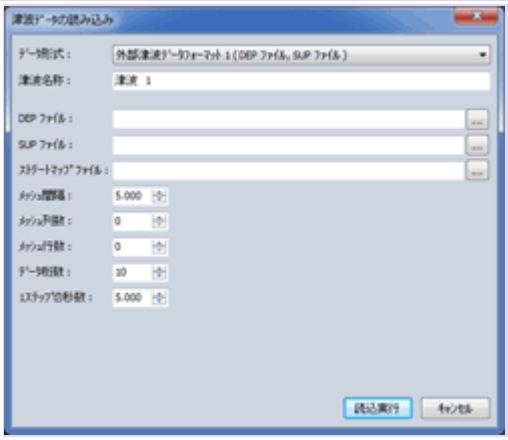
Expression of water surface reflection

Features / Functions

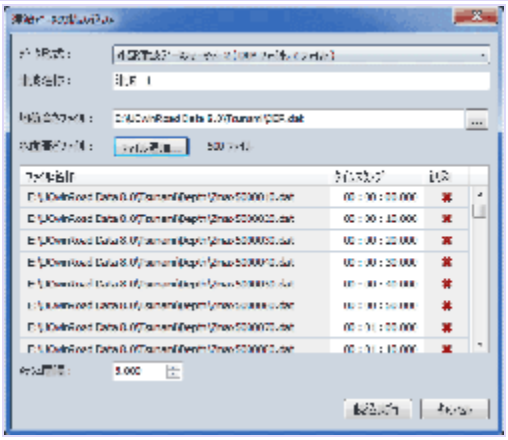
Import Tsunami data

- Tsunami plug-in standard format

- External tsunami data format 1 (DEP file, SUP file)
- External tsunami data format 2 (DEP file, Z file)

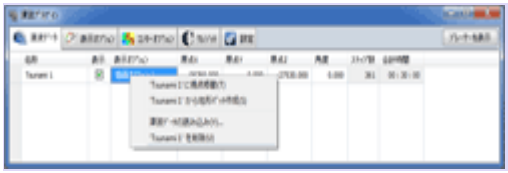


Importing external tsunami data format (DEP file, SUP file)

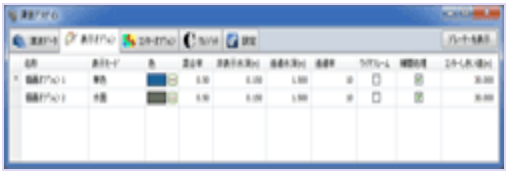


Importing external tsunami data format 2 (DEP file, Z file)

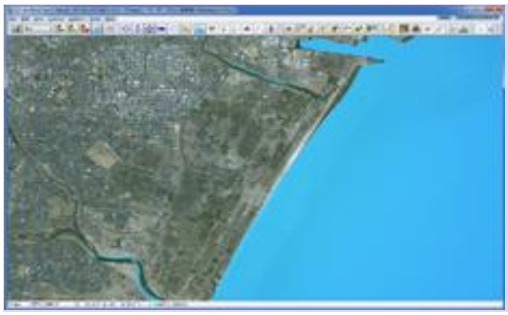
Creating the terrain patch from tsunami plug-in



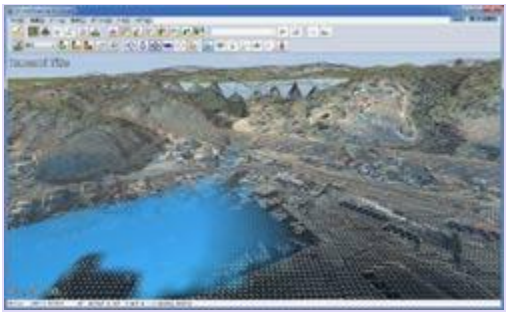
Screen for inputting tsunami data



Screen for inputting drawing option



Terrain and water surface from the top view



Drawing setting : Wire frame

VR-Design Studio Tsunami Plug-in file format information

The Tsunami VR-Design Studio plug-in imports tsunami analysis result to VR-Design Studio for visualization. Different analysis software export analysis results in different formats. This means that analysis results from around the world are produced in a variety of file formats.

FORUM8 has established a standard file format to enable tsunami analysis results produced in various different file formats to be imported into VR-Design Studio. The establishment of this feature is indeed a revolution as data can now be exchanged smoothly and seamlessly between VR-Design Studio and the 3rd party analysis programs.

A detailed specification of the standard file format has been released allowing FORUM8 users to convert their data in accordance to their working environment.

Future developments including the ability to visualize flow velocity and wave power. Our plan is to expand the standard file format by taking into account the kind of interoperability that can be used in every possible situation, in order to provide an even more flexible interaction between our 3D Visual Interactive Simulation and Modeling software and 3rd party analysis programs.

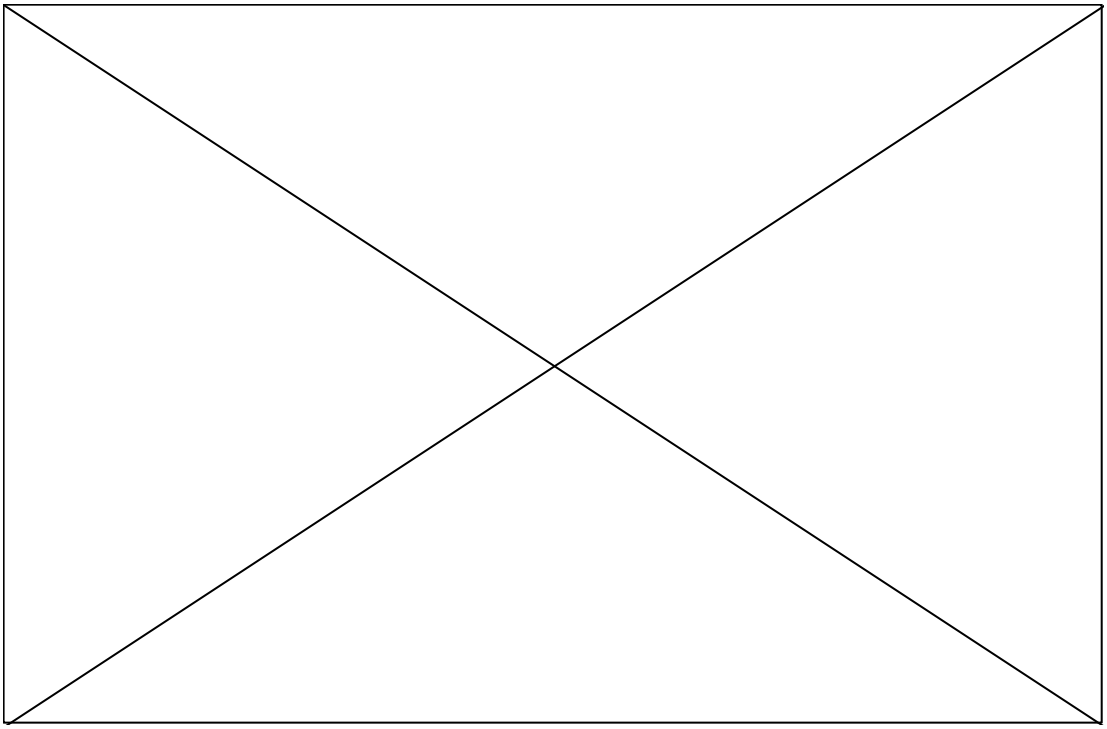
Related products and service

UC-win/Road for Tsunami

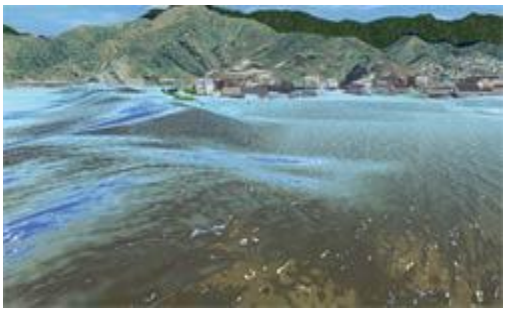
VR-Design Studio xpswmm plug-in (for Tsunami)

Tsunami analysis based on the difference method of the shallow water equation

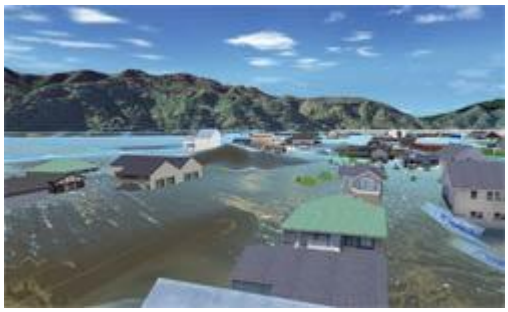
The plug-in is known for its feature that enables 3D VR software VR-Design Studio to visualize tsunami propagation in a very realistic manner.
Tsunami can be generated via xpswmm linkage; and tsunami position, range, and height can all be assigned on the Visual Options window.
The inundation zone and inundation height is predicted based on the difference method of the shallow water equation. Furthermore, the plug-in can evaluate the wave power imposed on houses and buildings and calculate flotsam/ jetsam/ driftwood/debris transport as well as the wave height and velocity at each mesh point and then draw a wave height distribution map. The model that relate to the research conducted at the Tohoku University Tsunami Engineering Laboratory (run by Professor Fumihiko Imakura) is proposed in this system.



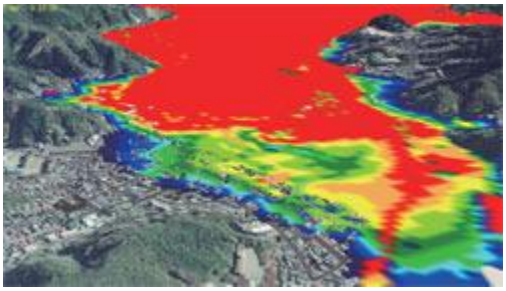
Linked with tsunami analysis software



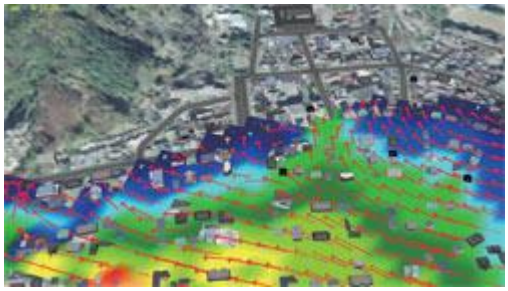
Reflection and inflection on water surface



Tsunami caused around buildings



A few seconds after from tsunami arrival (contour)



Vector expressing the flow velocity of tsunami

The Mechanism of Tsunami Development

The ground underneath the seabed protrudes or subsides when an earthquake having a focus beneath the seabed occurs. This diastrophism makes the sea surface agitate vertically causing big waves which then turns into the propagating tsunami.

When the tsunami warning is announced, sailors undock their vessel and sail offshore as means of evacuation to avoid potential damages to their vessel. This is indeed a very rational maneuver because out in the ocean the tsunami behaves more or less like a big and deep tide that does not have the kind of wave energy capable of flipping over a ship, the kind predominant in places near the coast during the tsunami of the same scale.

The term “Tsunami” is a combination of two Japanese characters, both of which were derived from China: The character “Tsu” which means port, and “Nami” which means wave. The two characters combine to make one term which refers to a very destructive wave. The reason why these two characters were chosen is because this catastrophic wave does more damage to the ships docked at the port rather than these offshore. Presently the word “Tsunami” is used extensively throughout the world.

Tsunami velocity is the square root of the product of water depth and gravitational acceleration （$v=\sqrt{gd}$）. If the water depth is assumed to be 4,000m, the tsunami velocity reaches approximately 720km/h（200m/s）, which is the speed equivalent to that of a jet.

The Mechanism of Tsunami Development

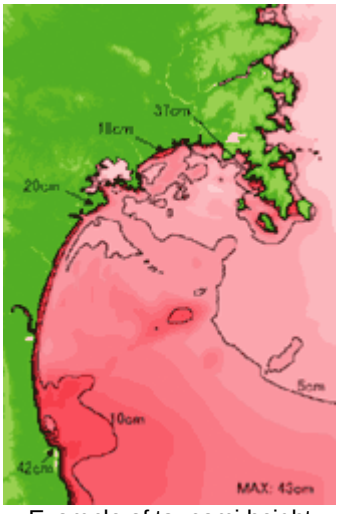
Overview

The Imamura Laboratory adopts the difference method of the shallow water equation for the numerical calculation of tsunami. The tsunami analysis involves a number of simulations including the river backflow simulation to predict the inundation area and inundation height if future tsunamis were to occur. These calculations are used to evaluate the wave power imposed on houses and buildings and predict flotsam/ jetsam/ driftwood/debris transport, and wave height as well as velocity at each mesh point to illustrate a wave height distribution over a map. The information on the seabed terrain comes

from the materials publically released by the Japan Coast Guard.

Conditions that can be input
The information describing the focus of the earthquake (the magnitude, distance between the focus and the epicenter, location), the seabed terrain data (seabed elevation and location), and terrain are all available to be input as conditions.

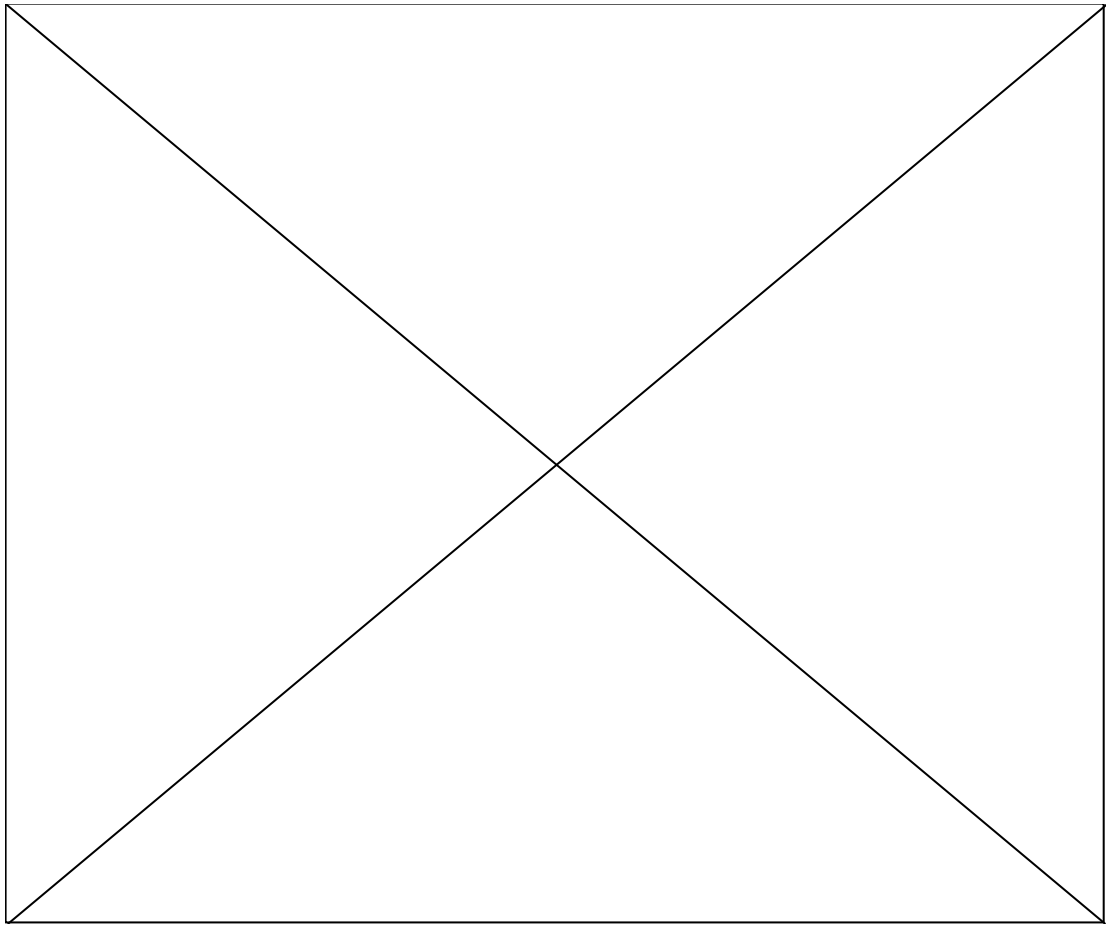
Example of Analysis Result :
An example of the result of calculation done on the Earthquake Off Fukushima Prefecture on July 19, 2008 is introduced here.
The scale of the earthquake is quite big (M =6.6), and the focus is approximately 10km underneath the earth's surface.
The research findings showed that the earthquake arrival time was 20 minutes behind the arrival time predicted by the Japan Meteorological Agency, however the former almost coincided with the observed arrival time, which proved the accuracy of the system.

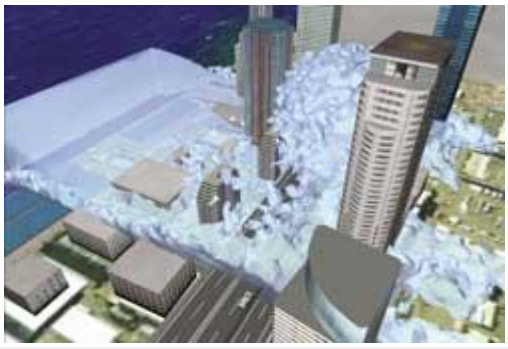


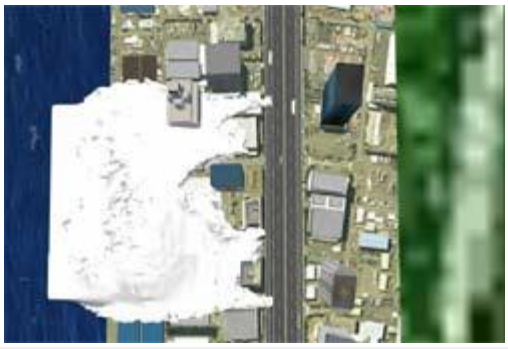
Example of tsunami height distribution

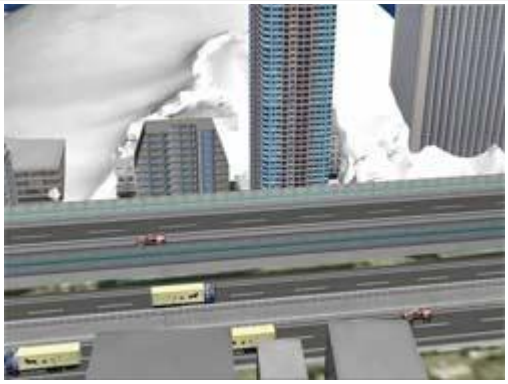
Tsunami Simulation
(Proposed model that uses the smoothed-particle hydrodynamics analysis result)

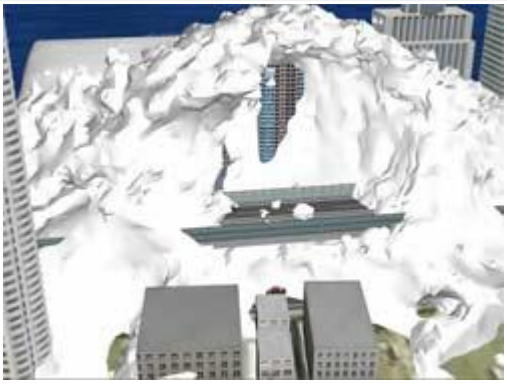
Snapshots below show a VR model in which the smoothed-particle hydrodynamics analysis result is put to action as movable model that moves over time within VR-Design Studio. (The actual analysis result is not applied. Instead, the expression of tsunami is made possible using a VR model.)











Tsunami Numerical Analysis Support Service

This is a complete set of analysis support service in which we take advantage of the practical tsunami analysis code developed in the Imamura Laboratory to create a hazard map or predict tsunami evacuation, or link the data with VR-Design Studio for a highly accurate visualization.
As long as this tsunami analysis code is used, a very accurate and useful hazard map or a very good prediction of tsunami evacuation can be made.
Because the basic information such as terrain, buildings, and trees are interfaced with Road data and imported into VR-Design Studio, manual input is not required saving a considerable amount of time. In addition, the analysis result of the tsunami analysis code are imported into VR-Design Studio for visualization.

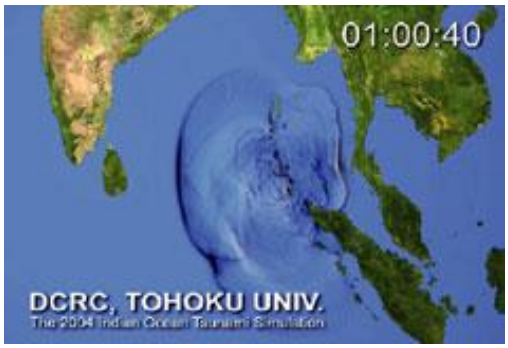
Conditions that can be input
The information describing the focus of the earthquake, the seabed terrain data, and terrain

Case Study on Tsunami Analysis
The result of calculation done on the Earthquake off Fukushima Prefecture on July 19, 2008. The predicted arrival time of the earthquake almost coincided with the observed arrival time.

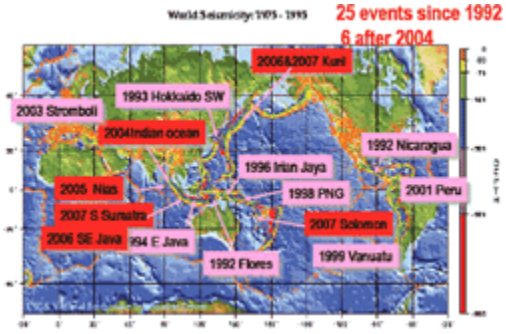
Details of the research being conducted in the Tohoku University Imamura Laboratory
The Tohoku University Imamura Laboratory (lead by Professor Imamura) are doing the following kind of research on tsunami.

Research details:
A disaster is a consequence of an interference between the natural forces and human activities within the society. As human activities and behavior change over time, so does the situation surrounding each and every type of disaster. In order to take effectives measure against future disasters we must not only base our potential measures on the aftermath of the past disasters but also predict the disaster propagation that undergo transformation with the development of society and to devise the kind of measure that has the potential to develop the region and at the same time protect it against vulnerabilities.

The Tsunami Engineering Laboratory is the only research institute in the world that conducts research on tsunami from the engineering standpoint. It is involved in the research based on field investigation in Japan and abroad and on measures against tsunami disaster for a particular region, as well as the development of tsunami's numerical value prediction system that is highly accurate, based on the key principle of disaster measure and control. In particular, its tsunami analysis technique is so accurate that it is expected to be spread to many tsunami-prone countries. In fact, the technology transfer itself is one of the project that Tohoku University is engaged in, which is called TIME（Tsunami Inundation Modeling Exchange）. Tsunami analysis codes developed by this research lab are already being used in more than7 countries for mitigation of the impact of tsunami disaster.



Analysis animation of Tsunami of the Indian Ocean (2004) (Tohoku University Tsunami Laboratory)



Location of tsunami of recent years

▲Several functions of coastal forest in Japan (Hamada & Imamura,2003)

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