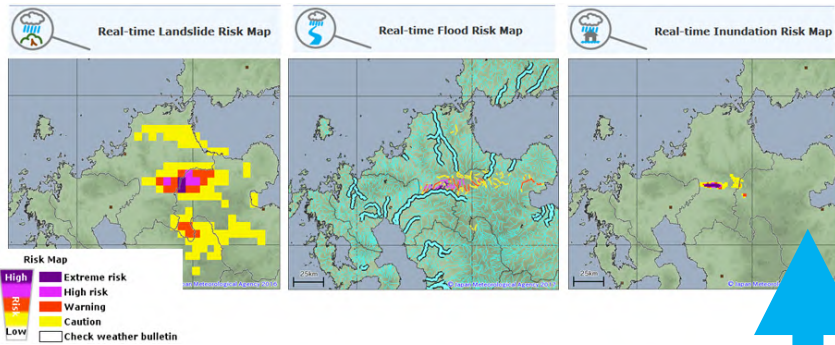# SOIL WATER INDEX, RUNOFF INDEX, AND SURFACE WATER INDEX
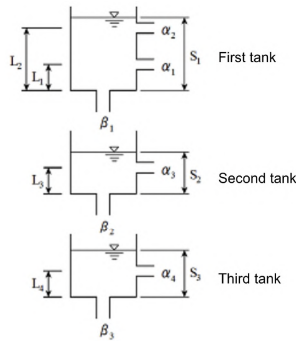
Outline

When hazardous weather conditions are expected, JMA issues a variety of information including Emergency Warnings, Warnings, Advisories and Bulletins so that appropriate measures can be taken to mitigate possible incidents. Such information is utilized for disaster risk reduction (DRR) activities such as the issuance of evacuation order/instructions by municipal authorities and advice on voluntary evacuation. Emergency Warnings, Warnings, Advisories and Landslide Alert Information are issued in consideration of Soil Water Index and Runoff Index values. Surface Water Index information can be used for Emergency Warnings, Warnings, and Advisories for heavy rain. These three indices are calculated using a tank model.

Tank model

The relevant tank model was developed more than 50 years ago by the National Research Center for Disaster Prevention (NRCDP) to predict river water levels based on rainfall observation. The original version of the model calculates rainfall amounts flowing into rivers with a temporal delay (Okada, 2000).
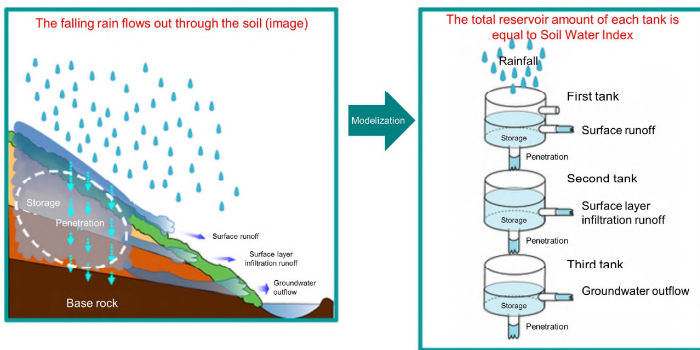
Three-tank cascade model
The tank model used by JMA is the one proposed by Ishihara and Kobatake (1979). The right figure shows a three-tank cascade model. The first, second and third tanks correspond to surface runoff, surface layer infiltration runoff and groundwater outflow, respectively.

Soil Water Index

The Soil Water Index provides estimations on average amounts of water stored in soil of certain areas, helping to clarify the risk of landslide-related incidents caused by heavy rain. JMA uses index values as criteria for the issuance of Emergency Warnings, Warnings Advisories for heavy rain and Landslide Alert Information.

Rainwater penetrates the ground surface and flows into rivers or into the ground. As the amount of water stored in soil increases, the risk of land slope collapse rises. Figure below shows a tank model simulating how rainwater flows out through soil. Each tank has a side outlet representing outflow to the surrounding soil and a bottom outlet representing outflow to deeper ground. Output from the side outlet of the first tank corresponds to surface runoff, that of the second tank corresponds to infiltration runoff at the surface layer, and that of the third tank corresponds to runoff as groundwater. Input to the first tank corresponds to rainfall, and input to the second and third tanks is output from the bottom outlet of the upper tank (infiltration runoff).

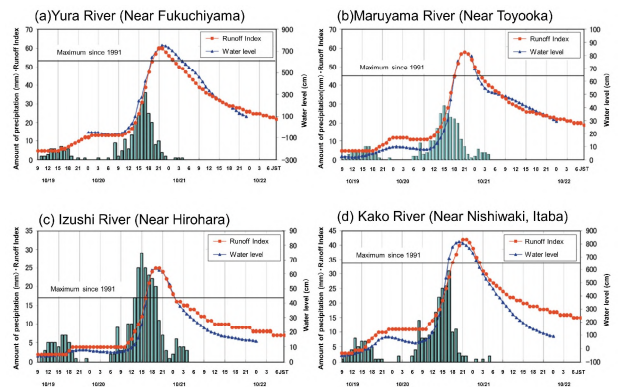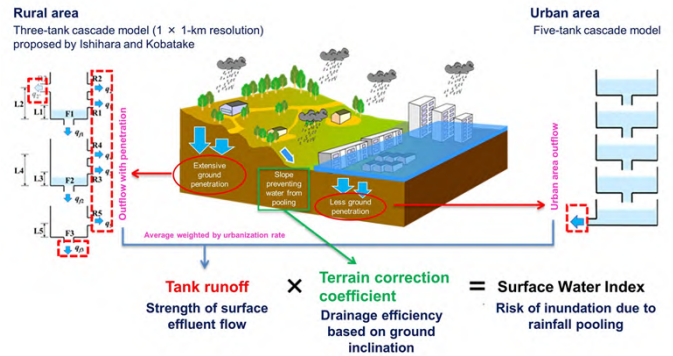Modeling of rainfall accumulation in soil and runoff

Runoff Index

The Runoff Index represents the probability and potential magnitude of rainfall-related flooding. It indicates the amount of rain water contained in rivers. Specifically, values express the amount of water at a certain point in a river with 1-km square resolution. Calculation is based on simulation in which precipitation flows into the river (runoff process) and flows downstream (flow process) with reference to information on the river channel, basin and land use.
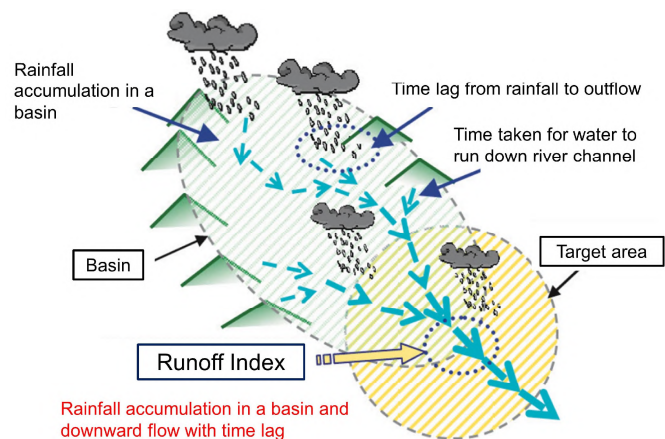JMA uses the Runoff Index for issuance of Flood Warnings and Advisories. The right figure outlines the concept of the index, which is calculated for all rivers in Japan and are registered in National Land Numerical Information.

Surface Water Index outline

Surface Water Index values indicate the risk of inland inundation caused by rainfall. Such inundation occurs when rainfall exceeds the capacity of sewers, roadside ditches and other drainage facilities, and is often seen in low-lying areas regardless of proximity to rivers. Accordingly, surface effluent flow is considered to play a pivotal role in inland inundation. Topographical gradients are also important factors; in areas with steep landform gradients, rainwater flows rapidly downstream and is less likely to accumulate. Based on this concept, the Surface Water Index was designed for estimation of runoff amounts using a tank mode with landform-induced correction.

River water levels and Runoff Index values associated with the landfall of Typhoon No. 23 in 2004

Rainfall accumulation in a basin and downward flow with time lag

Conceptual chart of The Runoff Index