

Surface Water Transport of Radioactivity from the Fukushima Nuclear Power Plant Incident

> William B. Samuels, Ph.D and Rakesh Bahadur, Ph.D Science Applications International Corporation Center for Water Science and Engineering McLean, Virginia

American Meteorological Society 92nd Annual Meeting January 22-26, 2012 New Orleans, LA



CATS7W Earthquake epicenter and nuclear plant locations





CATS7W

Instrumental Intensity (A scale of earthquake intensity based on observed effects and ranging from I (detectable only with instruments) to XII (causing almost total destruction).



© 2008 Science Applications International Corporation. All rights reserved. SAIC and the SAIC logo are registered trademarks of Science Applications International Corporation in the U.S. and/or other countries.



- Development of Geospatial Stream Flow Model (GeoSFM)
- Benchmarking of Flow Model
- ICWater Model Application for Fukushima
- Interface to SHARC



Riverine Modeling

- CONUS
 - ICWater









Energy | Environment | National Security | Health | Critical Infrastructure

© 2008 Science Applications International Corporation. All rights reserved. SAIC and the SAIC logo are registered trademarks of Science Applications International Corporation in the U.S. and/or other countries.

GeoSFM Overview



Riverine Hydrodynamic Methods





Rainfall from CMORPH

Daily Precipitation for: 15 Feb 2009 (00Z-00Z) Data on .25 x .25 deg grid; UNITS are mm/day

CMORPH Precipitation Estimates



SAIC.

Potential Evapotranspiration (PET)





Terrain Analysis





USGS Landuse/Land Cover

🖃 🗹 usgslandcov1	DESCRIPTION
Value	Urban and Built-Up Land
1	Dryland Cropland and Pasture
2	Irrigated Cropland and Pasture
3	Cropland/Grassland Mosaic
5	Cropland/Woodland Mosaic
6	Grassland
7	Shrubland
8	Mixed Shrubland/Grassland
9	Savanna
10	Deciduous Broadleaf Forest
12	Deciduous Needleleaf Forest
13	Evergreen Broadleaf Forest
14	Evergreen Needleleaf Forest
15	Mixed Forest
16	Water Bodies
17	Herbaceous Wetland
19	Barren or Sparsely Vegetated
21	Wooded Tundra
22	Mixed Tundra





Digital Soils Map





Flow Model



Benchmarking of Flow Model

GRDC	Observed	Modeled Flow
Observation	Flow (CMS)	(CMS)
Station		
2588650	140.87	118.6
2588651	124.5	92.3
2000001		5210
2588652	107.46	71.8
2588653	64.85	46.3
2588654	25.51	31.6
2588655	27	17.7



Transport and Dispersion using ICWATER



Rainfall – Runoff Relationship





Properties and Dose Information in ICWater I-131 and Cs-137

Details for Agent: I-131

Classification: Radiological Subtype: Beta and Gamma

Agent Properties

Agent Name:	I-131		
Subtype:	Beta and Gamma		
LOC mCi:	1180	Reference:	EPA reference
Half Life (days):	8.04	Reference:	EPA reference

Principle decay modes	beta, photon
Specific Activity (Ci/g)	124000
LD50/60 (mCi) - Adult	1180
LD50/60 (mCi) - Child	470
1% Fatal Cancer Dose (mCi) - Adult	3
1% Fatal Cancer Dose (mCi) - Child	0.2

Details for Agent: Cs-137

Classification: Radiological Subtype: Beta and Gamma

Agent Properties

Agent Name:	Cs-137		
Subtype:	Beta and Gamma		
LOC mCi:	113	Reference:	EPA reference
Half Life (days):	10950	Reference:	EPA reference

Principle decay modes	beta, photon
Specific Activity (Ci/g)	87
LD50/60 (mCi) - Adult	113
LD50/60 (mCi) - Child	40
1% Fatal Cancer Dose (mCi) - Adult	0.3
1% Fatal Cancer Dose (mCi) - Child	0.2



Dilution and Travel Time





Rainfall Data (CMORPH) April 24, 2011





Cs¹³⁷ concentration April 24





Source Term and Downstream Trace

Location	North River	South River
Soil Monitoring in Watershed	100,000 Bq/kg	9900 Bq/kg
Peak Conc. (headwaters)	70,786 Bq/L	32,512 Bq/L
Peak Conc. (Ocean discharge)	12,377 Bq/L	2,228 Bq/L
River Dilution Factor	5.7	14.6
Sea monitoring north of NPP ¹	200 Bq/L	200 Bq/L





Breakthrough Curves



Breakthrough Curve @ Location 1 North River



Breakthrough Curve @ Location 2 South River



Model-to-Data Comparison ICWATER Source Location 1 and Offshore Stations 07MAY2011 Cesium-137



Note: Sampling activities on 07MAY were curtailed due to inclement weather. Riverine discharge at Location 1 was transported to the north and nearshore stations did not intersect with the material. At offshore station S-1, model predictions were below the detection limit.



Summary and Next Steps

Summary

- River model built for Japan
- Benchmarking of modeled flows with observations
- Travel times and dilution factors calculated
- Source term investigation initiated
- Downstream tracing and breakthrough curves calculated
- Export to SHARC

Next Steps

- Data sharing with other modeling groups
- Improve source term
- Perform additional model runs and validation

