Pacific Northwest
NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

GENII – Environmental Radiation Dosimetry Software

BRUCE A. NAPIER

U.S. Nuclear Regulatory Commission RAMP Training, Taipei, Taiwan

What is the Assessment Question?

- Are we compliant?
  - Often, regulatory requirements of facility operations are posed in terms of radiation dose limits
- Design requirements
  - How much material may be released and still meet the criteria?
- Safety Analyses
  - How much redundancy is necessary to prevent this event?
- Accident Planning
  - How bad could this event be?

Scenario Analyses

- All of these questions can be answered through the analysis of a *scenario* that considers
  - Radionuclide inventories,
  - Radionuclide releases,
  - Environmental transport,
  - Environmental accumulation and dilution,
  - Subsequent human exposure.

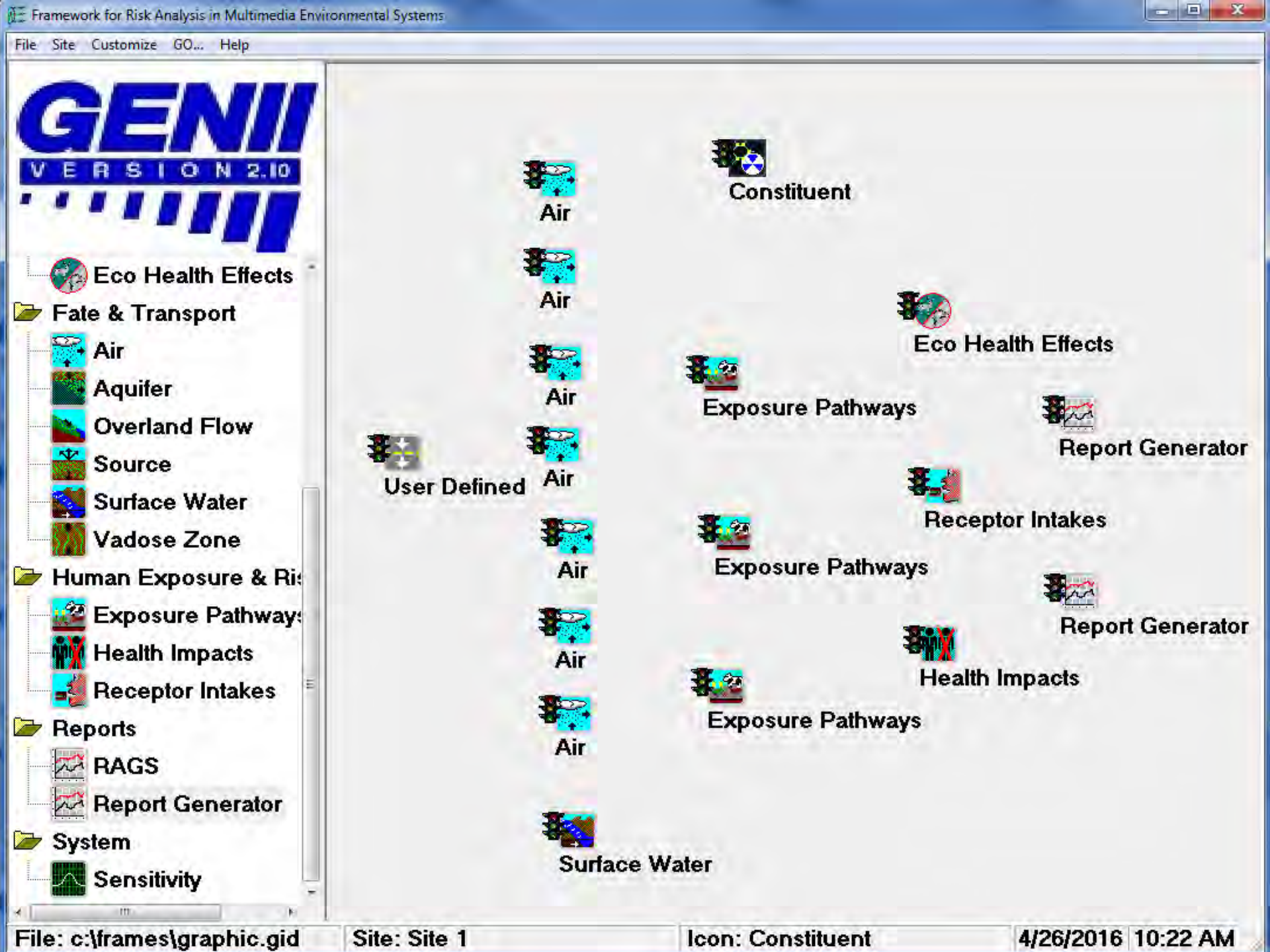
Scenarios

- A *scenario* is a conceptual model that describes patterns of human activity, events, and processes that result in radiation exposure to people.

- GENII is designed to allow flexible application to most scenarios of interest in a regulatory setting at an appropriate level of detail.

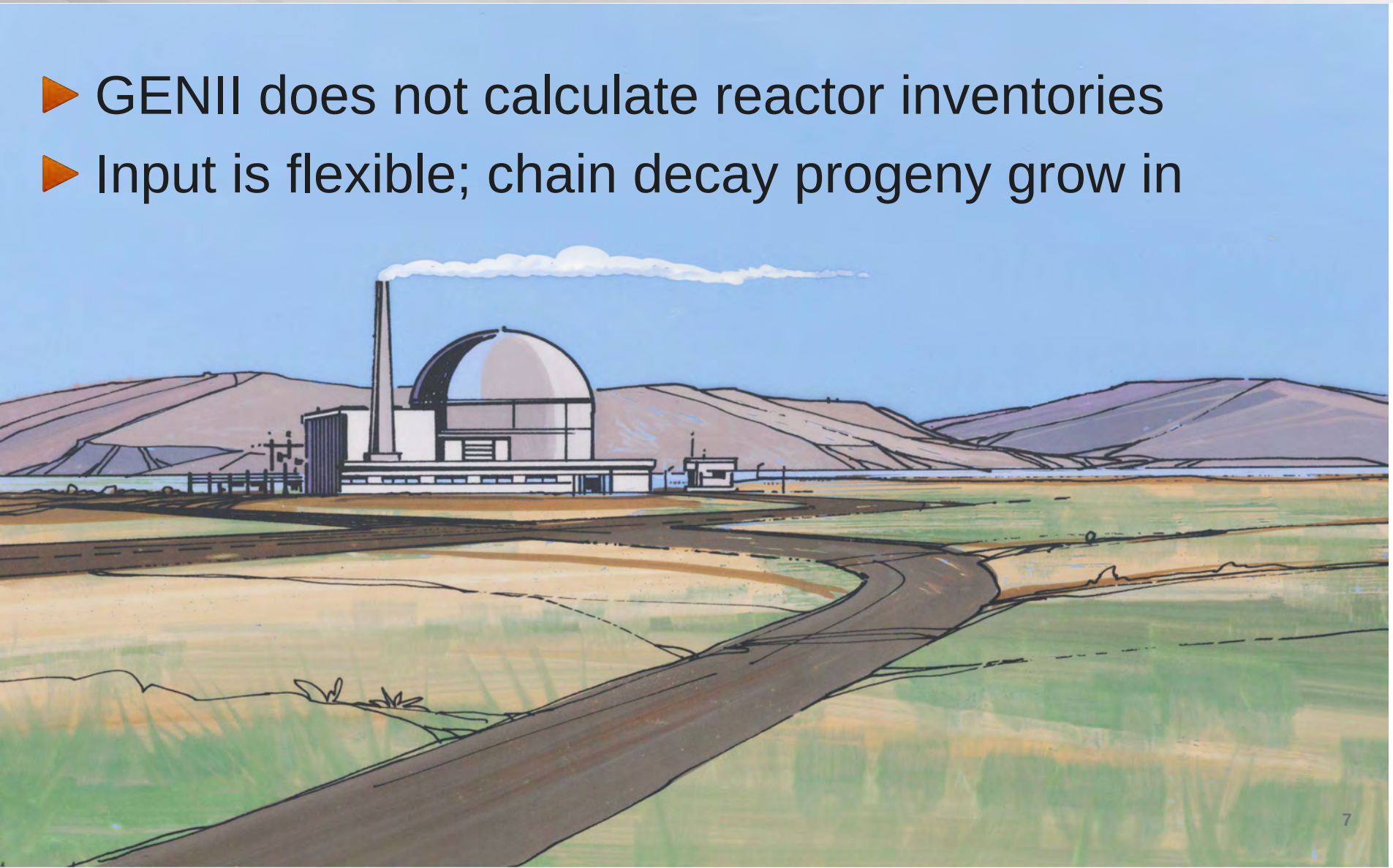
Types of Scenarios

- Far-Field scenarios
  - Atmospheric transport (Acute or chronic)
  - Surface water transport (Acute or chronic)
- Near-Field scenarios
  - Spills
  - Buried waste
  - (Groundwater use - GW transport modeling is NOT an explicit part of GENII)


Framework for Risk Analysis in Multimedia Environmental Systems
File Site Customize GO... Help
GENII
VERSION 2.10
Eco Health Effects
Fate & Transport
Air
Aquifer
Overland Flow
Source
Surface Water
Vadose Zone
Human Exposure & Ris
Exposure Pathways
Health Impacts
Receptor Intakes
Reports
RAGS
Report Generator
System
Sensitivity
Air
Air
Air
Air
Air
Air
Constituent
Eco Health Effects
Exposure Pathways
Report Generator
User Defined
Receptor Intakes
Exposure Pathways
Report Generator
Health Impacts
Exposure Pathways
Surface Water
File: c:\frames\graphic.gid
Site: Site 1
Icon: Constituent
4/26/2016
10:22 AM

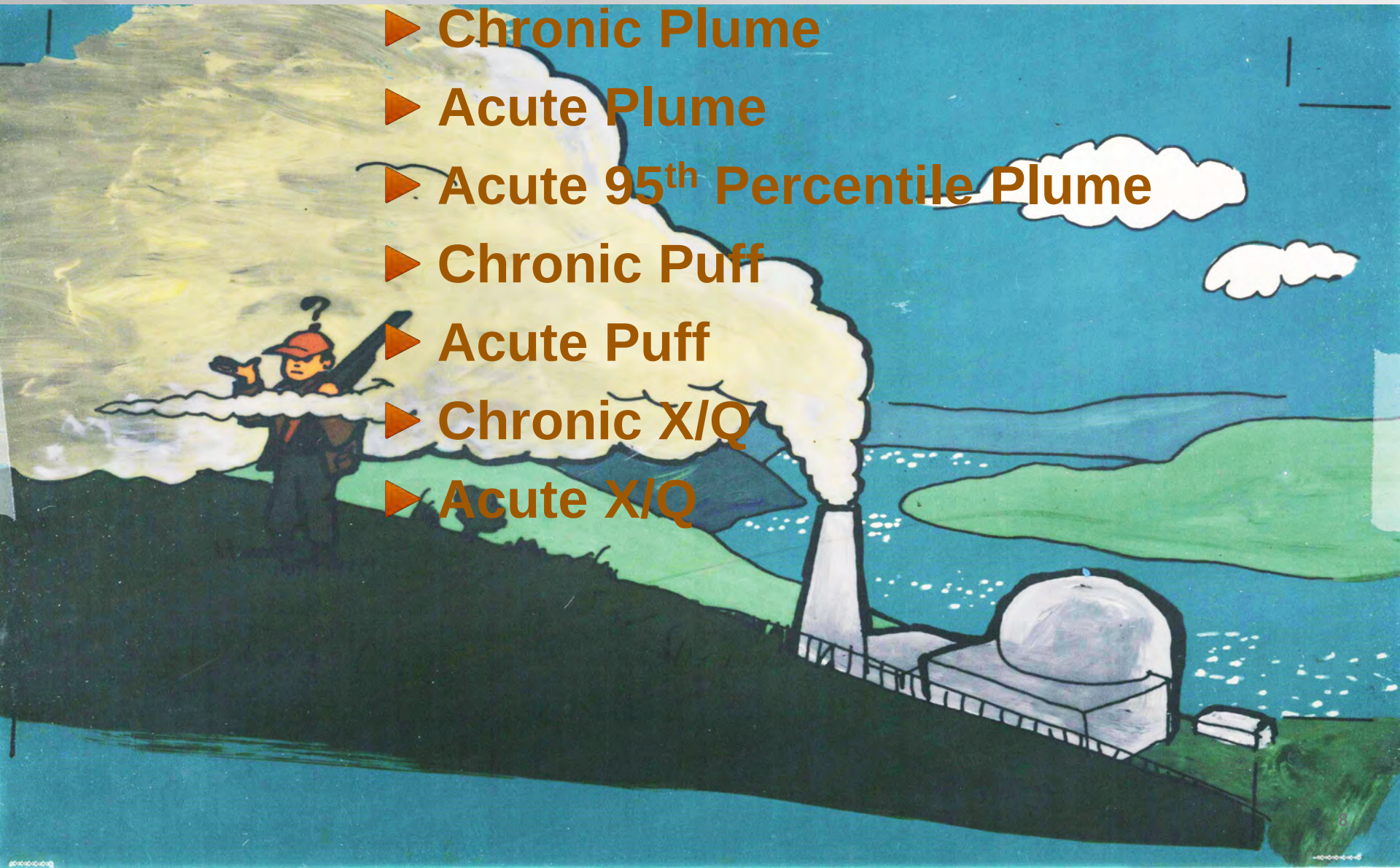
Radionuclide Source Terms

- GENII does not calculate reactor inventories
- Input is flexible; chain decay progeny grow in



7 Atmospheric Transport Models

Pacific Northwest
NATIONAL LABORATORY
Proudly Operated by Battelle *Since 1965*



- Chronic Plume
- Acute Plume
- Acute 95th Percentile Plume
- Chronic Puff
- Acute Puff
- Chronic X/Q
- Acute X/Q

4 Surface Water Models

- Chronic River
- Chronic Flow Dilution
- Acute River
- Near-shore Lake / Ocean

Options for types of initial impoundments:

- Once-through pond
- Fully-mixed pond
- Partially-mixed pond

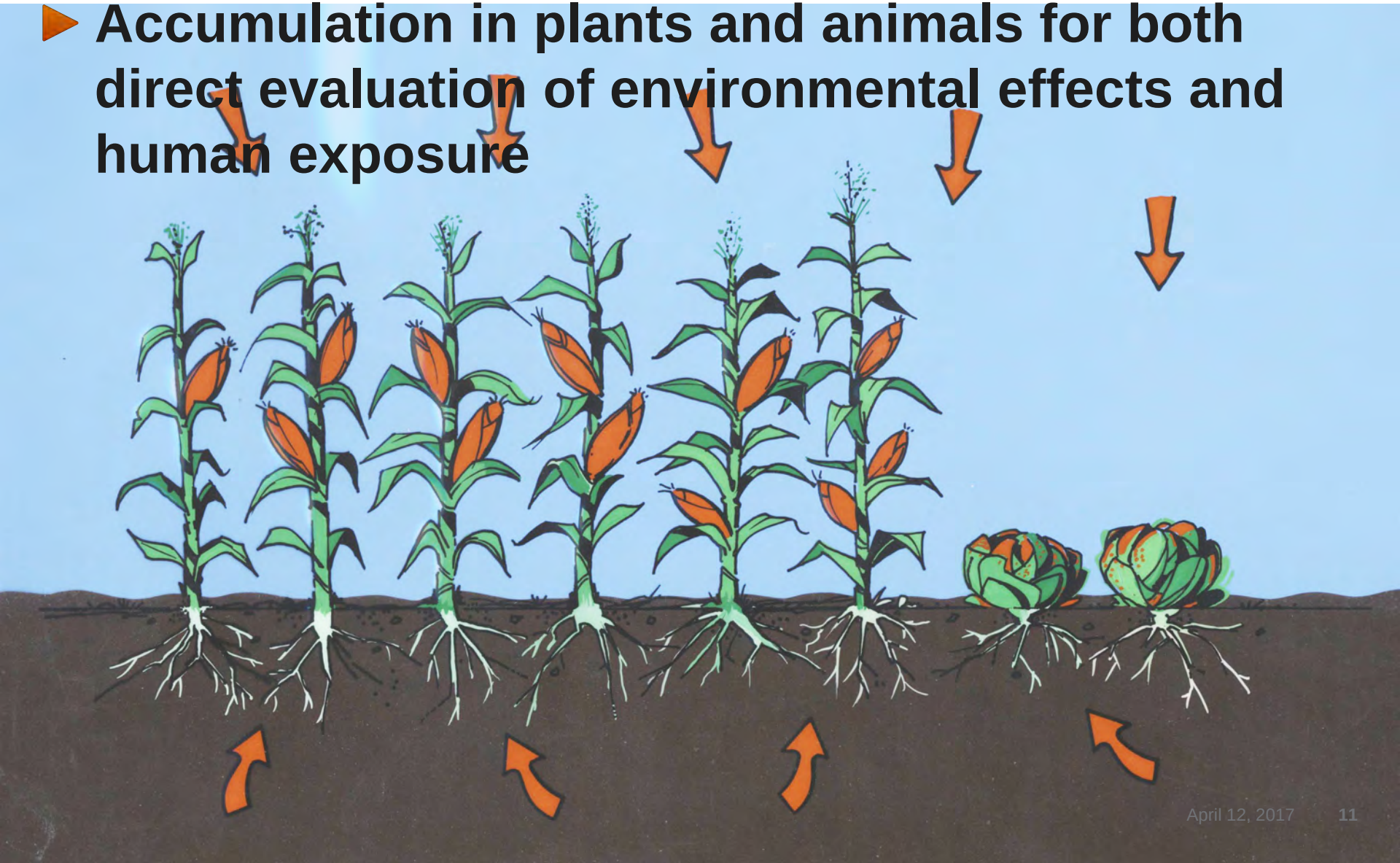
3 Accumulation / Exposure Models

Pacific Northwest
NATIONAL LABORATORY
Proudly Operated by Battelle *Since 1965*

Biotic Transport and Exposure

Pacific Northwest
NATIONAL LABORATORY
Proudly Operated by Battelle *Since 1965*

- **Accumulation in plants and animals for both direct evaluation of environmental effects and human exposure**



Human Intrusion

- Models for evaluating transfer of buried waste to soil surface; resuspension; etc.

Human Exposure Pathways

- External
  - Transported air
  - Soil
  - Swimming
  - Shoreline
- Inhalation
  - Transported air
  - Resuspended soil
  - Volatilized indoor air pollutants from water

Human Exposure Pathways

- Ingestion
  - Leafy vegetables
  - Other vegetables
  - Fruit
  - Grain
  - Meat
  - Milk
  - Poultry
  - Eggs
  - Fish
  - Crustaceans
  - Molluscs
  - Water plants
  - Drinking water
  - Shower water
  - Swimming water
  - Soil

GENII V.2 Acute-Deposition Food Pathways

- GENII V.2 presents results for 4 seasons (Winter/spring/summer/autumn)
- "Seasons" are surrogates for complex sets of underlying assumptions about plant growth, weathering, uptake, and time-to-harvest
- Selection of season depends on meteorological input (this is related to the uncertainty capability)
- *Seasons below the equator are reversed! A minor change in an external file to adjust…*

GENII V.2 Human Exposure

- Up to 6 age groups allowed, following ICRP-56,67,69

3 months	0-1 year
1 year	1-2 year
5 year	2-7 year
10 year	8-12 year
15 year	13-17 year
20 + year	17- 110 year

External Exposure - Doses

- Dose rate conversion factors from Federal Guidance Report 12, provided by Keith Eckerman, ORNL
  - Air Submersion
  - Water Immersion
  - Soil Plane
  - Soil Volume

Internal Exposure - Doses

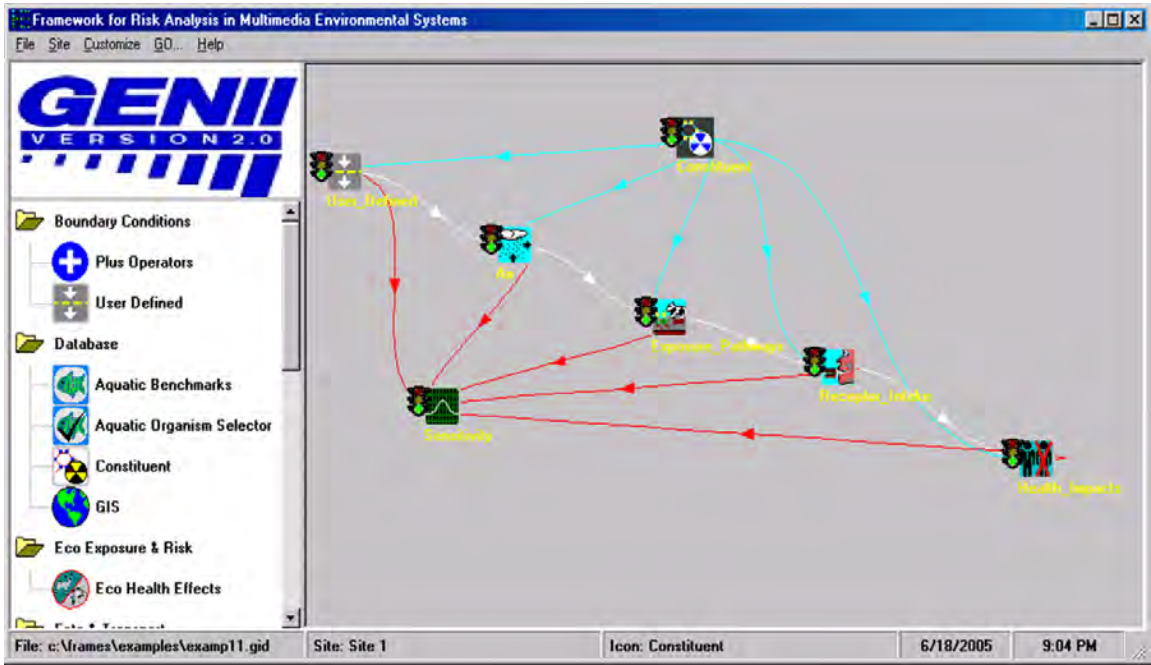
- Effective dose equivalent: ICRP-30
  - Adult only
- Effective dose: ICRP-72
  - 6 age groups
  - 24 organs/tissues
  - Inhalation classes F, M, S

Risk Calculations - FGR 13

- US Federal Guidance Report 13 provides coefficients for 15 cancer sites
  - Inhalation (risk/Bq)
    - Inhalation classes F, M, S
  - Ingestion (risk/Bq)
    - Accounts for different consumption patterns with age
      - Drinking water
      - Food crops

GENII V.2 Uncertainty Analysis

- Parameter uncertainty and sensitivity may be addressed using the SUM^3 processor in FRAMES.
- All non-control parameters are allowed to be varied, using description files to define 'available' parameters
- Acute atmospheric releases are an important subset. SUM^3 is used to vary start times, creating distribution functions of dose.



GENII Version 2: A General Purpose Environmental Dosimetry Tool

Pacific Northwest
NATIONAL LABORATORY

Proudly Operated by Battelle *Since 1965*