Pesticide Risk Reduction Programme – Ethiopia

Selected models for surface water

Mechteld ter Horst,Paulien Adriaanse, Jos Boesten, John Deneer,
Alterra

joint collaborative programme on pesticide registration and post-registration

MoA

Towards a sustainable use of pesticides in Africa

Selected models for surface water

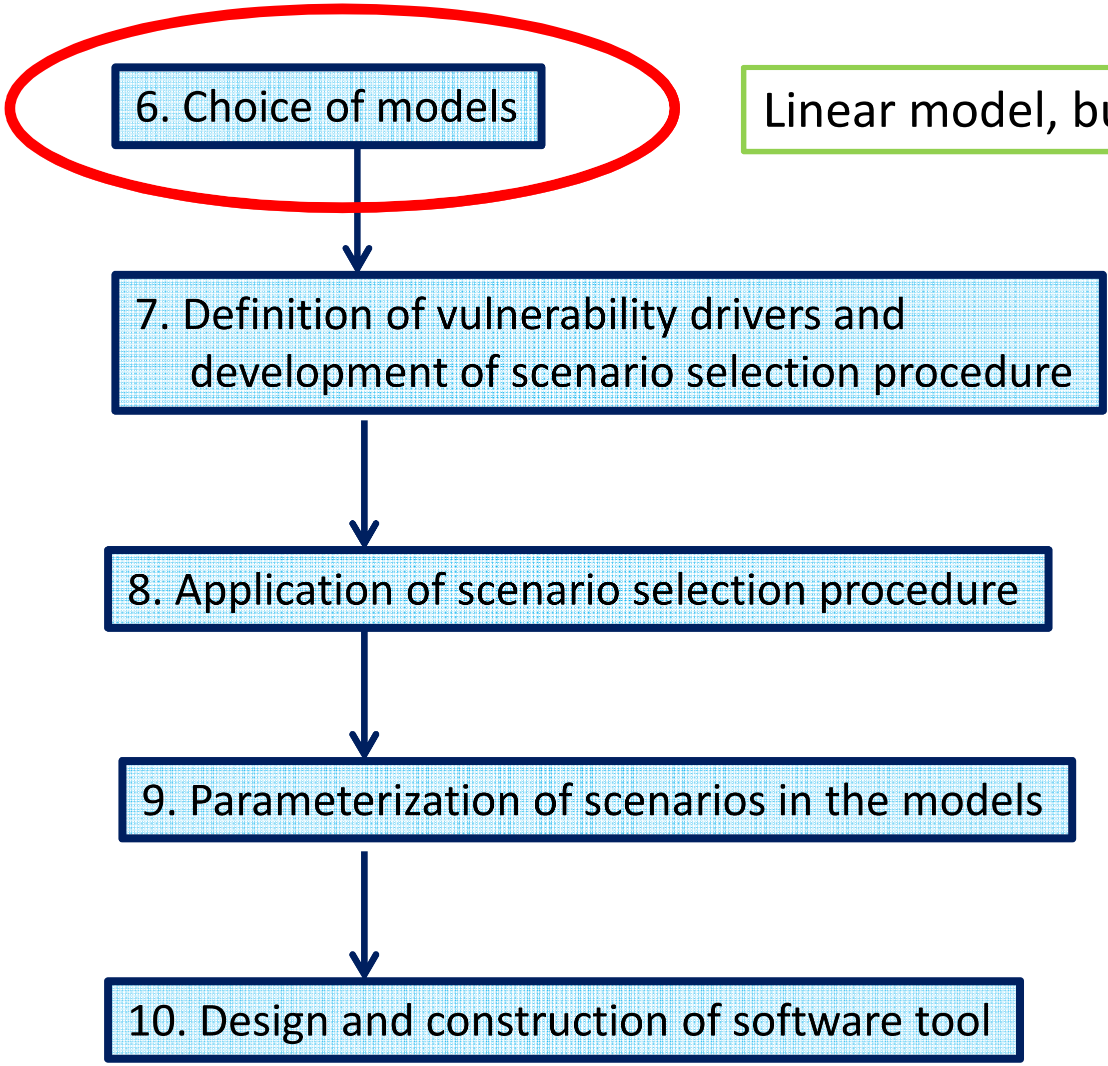
Outline

- Goal of this presentation
- Entry routes
- Spray drift curves
- Model for runoff
- Model for fate in surface water

Definition of protection goals

1. Data gathering
2. Identification of scenario zones
3. Options for protection goals
4. Choice of protection goals per scenario zone
5. Definition of conceptual model for protection goals

Scenario selection and parameterization

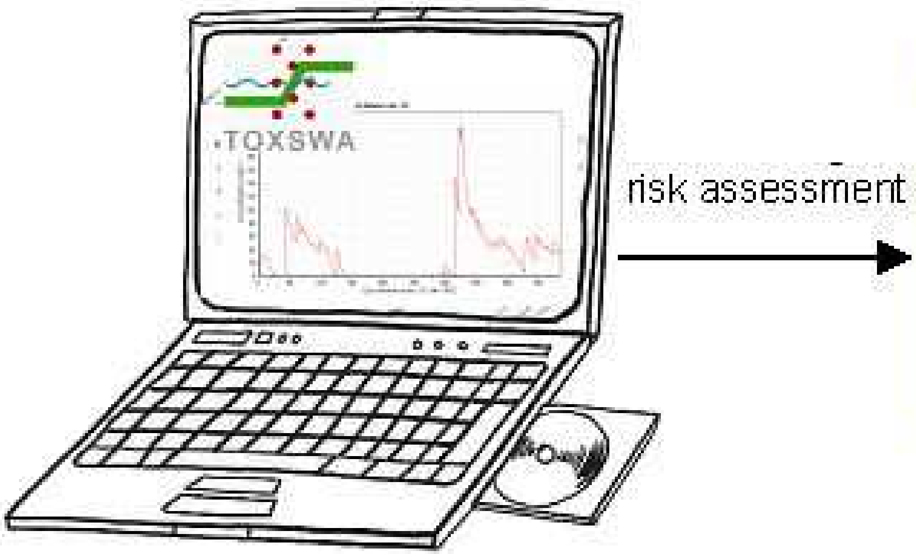


Linear model, but loops occur !

Selected models for surface water

Goal:

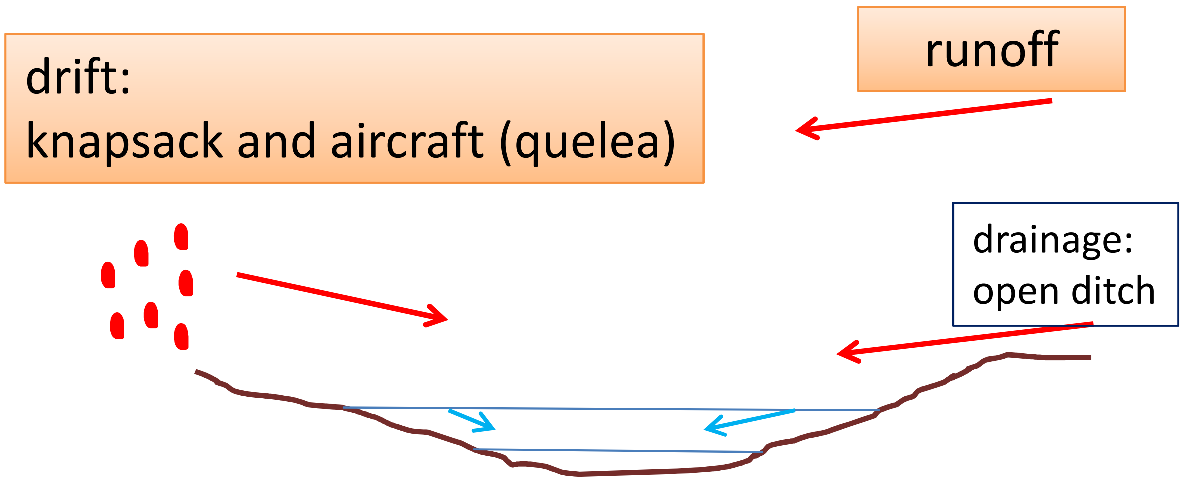
Introduction to models to estimate pesticide entries and concentrations in surface water



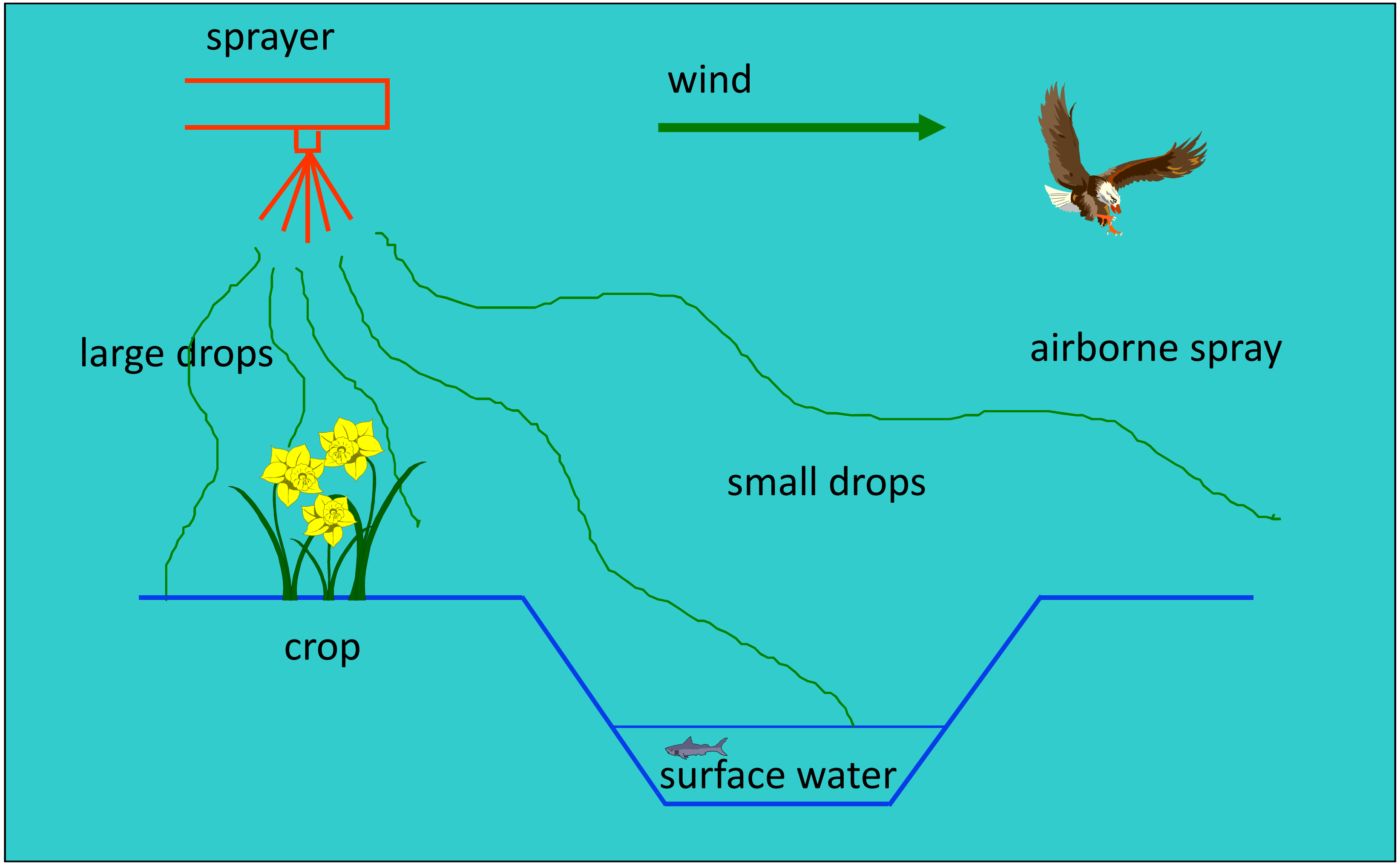
Selected models for surface water

Entry routes

Most important entry routes of pesticides in to the surface water

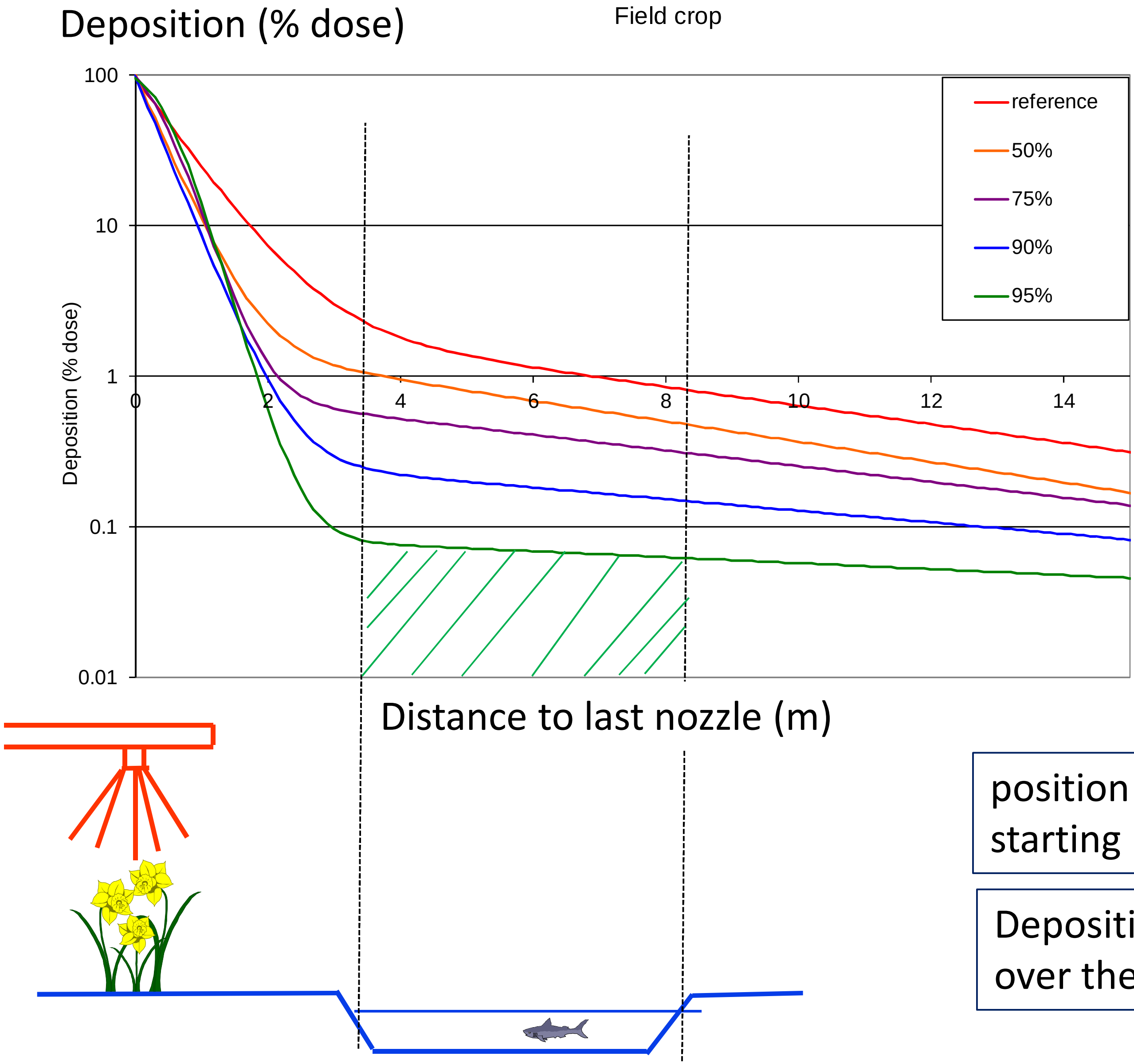


Selected models for surface water: Drift



Drift can be defined as spray which unintentionally reaches areas outside the target area, either as droplets, dry particles or vapour

Selected models for surface water: Drift



Different types of nozzles
(% drift reducing)

Drift curve is function of

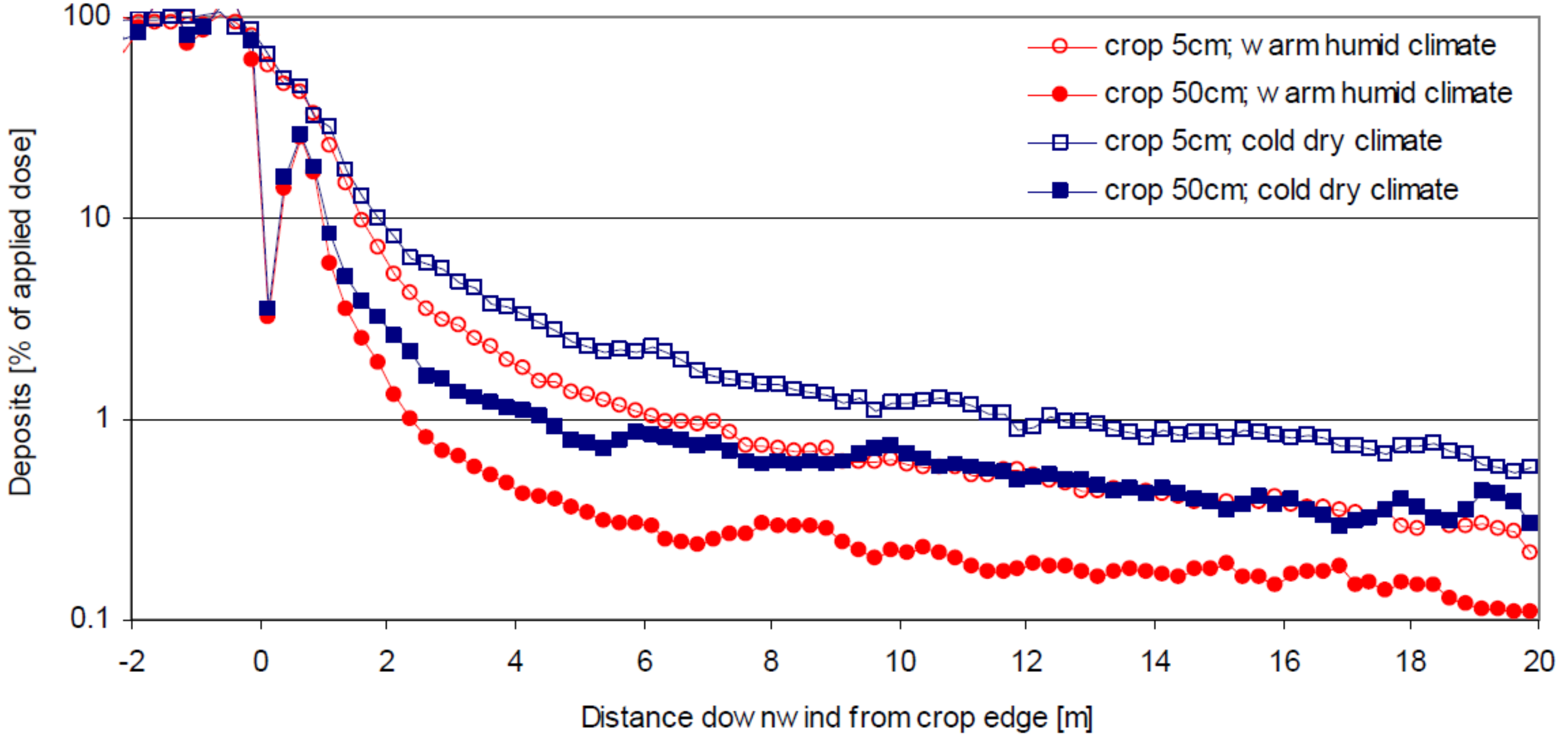
- Application technique
- Nozzle type
- Pressure

position of the last nozzle defines the starting point of the spray drift curve

Deposition on ditch by integration over the width of the ditch

Selected models for surface water: Drift

Hand held sprayers (knapsac)



- Drift deposits of knapsac sprayers as function of distance from the crop edge simulated by the IDEFICS drift model (from Franke et al., 2010)
- Crop 50 cm → simulations are comparable to field data from Netherlands and Philippines

Selected models for surface water: Runoff

Proposed model:

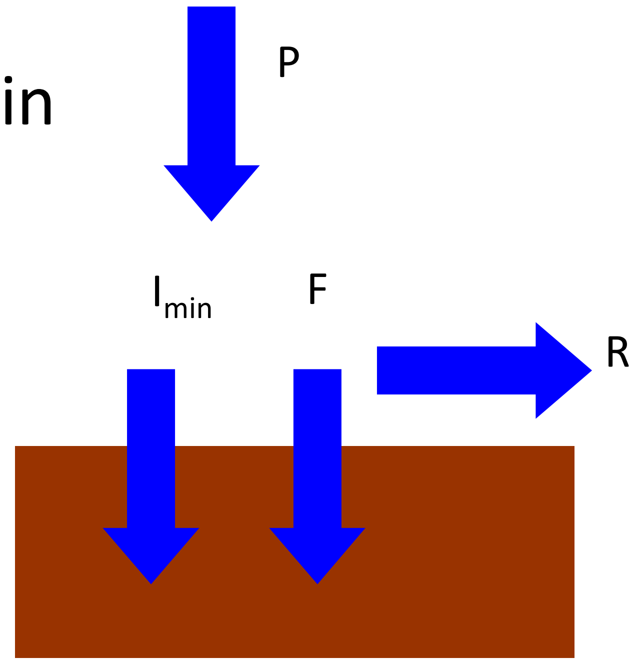
- PRZM (Pesticide Root Zone Model) model (Carsel et al., 1998)
  - Simulates pesticide runoff from agricultural fields
  - Used in USA and EU

Agricultural runoff can carry sediment, nutrients and pesticides to surface waters.
USDA Soil Conservation Service

N.B. PRZM calculates
sheet runoff flow, not via gullies !

Selected models for surface water: Runoff

Conceptual basis of runoff modelling in PRZM



- **daily rainfall** input, *P*, and runoff output, *R*

- a soil-plant system can store initially a minimum amount of water, I_{min}, before any runoff starts

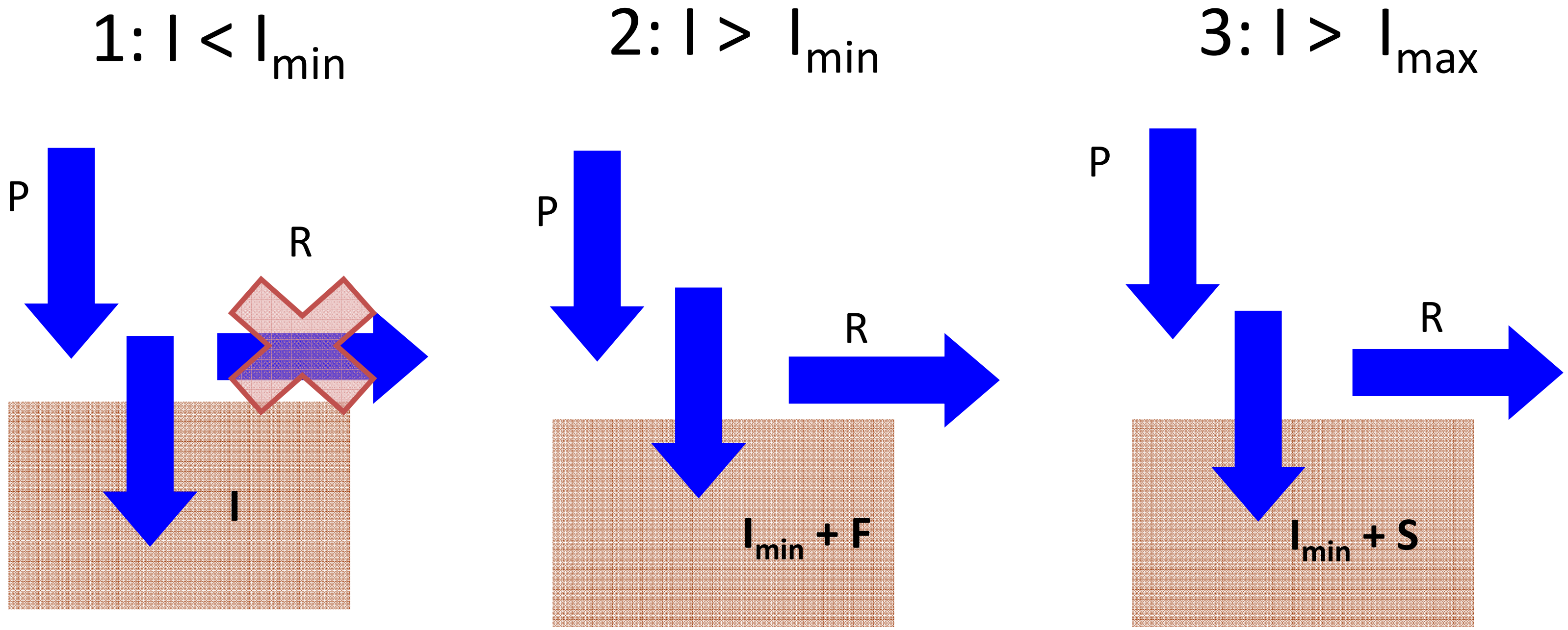
- after the runoff has started, the infiltration into soil continues: F is the total daily infiltration additional to this initial amount I_{min}

- we assume that I_{min} is a fixed value (independent of daily rainfall)

- so $P - I_{min}$ is the potential amount of runoff

Selected models for surface water: Runoff

3 situations



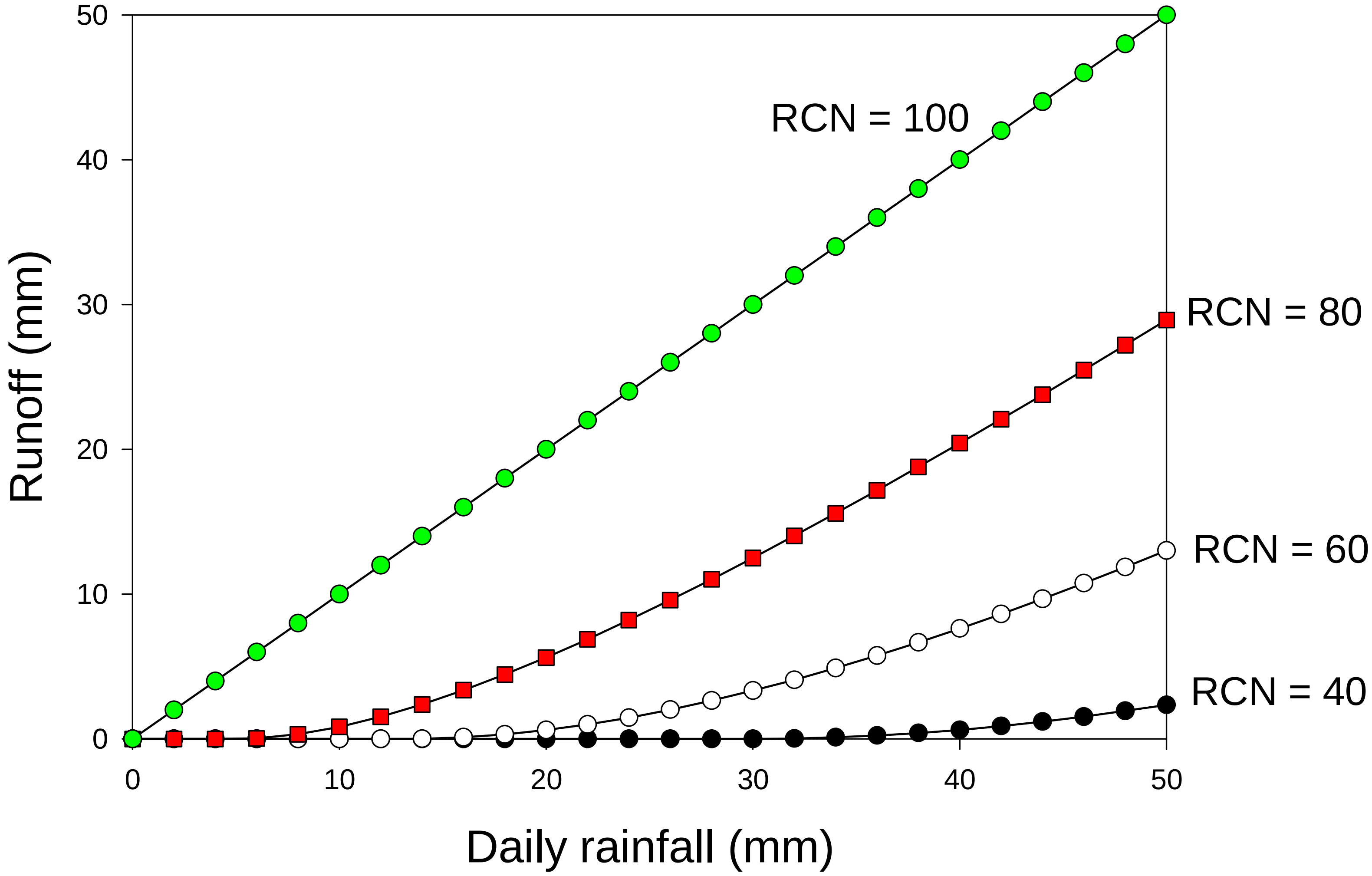
- Potential runoff = P – I_{min}
- S = F_{max} = the maximum depth of rainfall (excl. I_{min}) that could potentially infiltrate at a site
- S is a function of the Runoff Curve Number (RCN)

Selected models for surface water: Runoff

Runoff Curve Number (RCN)

- The *RCN* ranges between 0 and 100
- The higher the curve number, the greater the runoff (see next slide)
- The *RCN* is a function of soil type (classified in soil hydrologic groups A, B, C, D) with a reference moisture content, soil drainage properties, crop type and land use management practice.
- *RCN*s are listed in tables (Carsel et al., 1998; Hudson, 1989).

Effect of runoff curve number (RCN) on runoff-rainfall relationship



RCN between 30 and 95 so RCN has enormous effect on runoff

Selected models for surface water: Runoff

Runoff Curve Number (RCN)

- Source N. Hudson, 1981, Soil Conservation, p. 118

- A: excessively drained sands and gravels
- B: medium textures
- C: fine texture or soils with a layer impeding downward drainage
- D: swelling clays, claypan soils or shallow soils over impervious layers

Selected models for surface water: Runoff

EU FOCUS R4 scenario-specific runoff curve numbers for PRZM

[a] 2 crops per season with simulations performed separately for early crop and late crop
[b] Perennial crops

Crop group	Runoff curve number (antecedent moisture condition II)			
	Emergence (cropping)	Maturation (cropping)	Harvest (residue)	**Fallow**
Cereals, spring	81	81	86	**91**
Cereals, winter	81	81	86	**91**
Citrus [b]	70	70	70	**70**
Field beans	82	82	87	**91**
Legumes	78	78	85	**91**
Maize	82	82	87	**91**
Olives [b]	70	70	70	**70**
Pome/stone fruit [b]	70	70	70	**70**
Soybean	82	82	87	**91**
Sunflowers	82	82	87	**91**
Vegetables, bulb	82	82	87	**91**
Vegetables, fruiting	82	82	87	**91**
Vegetables, leafy [a]	82	82	87	**91**
Vegetables, root	82	82	87	**91**
Vines [b]	**70**	**70**	**70**	**70**

Selected models for surface water: Runoff

Proposal for Ethiopia

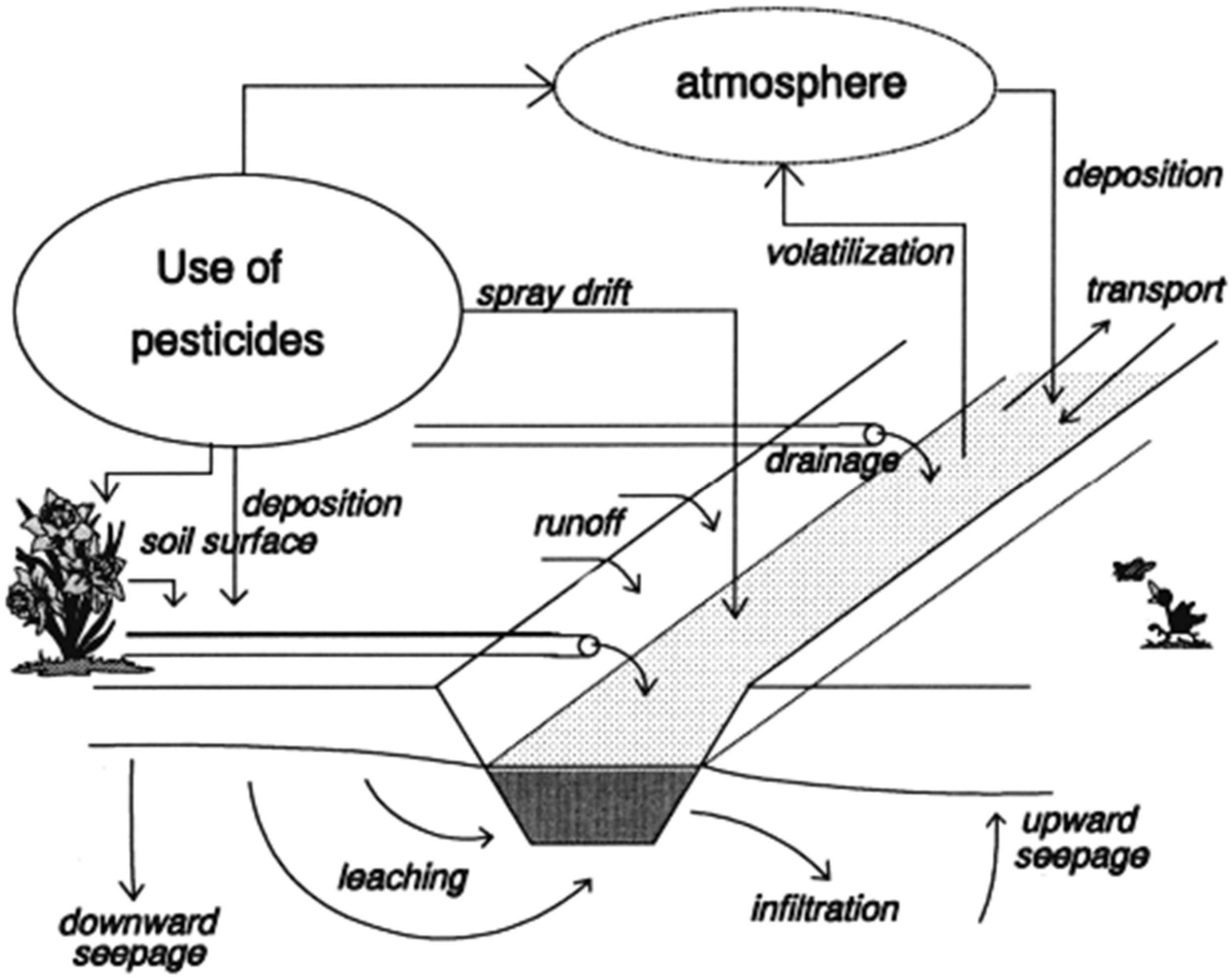
- Take the R4 (worst case EU) standard PRZM input
  - Parameterising soil for PRZM is too ambitious in PRRP
- Use Ethiopian weather (daily rainfall and evapotranspiration)
- Use Ethiopian crops

Selected models for surface water: Fate in SW

- Selected model: TOXSWA

- Developed by ERA team of Alterra
- Used in NL and EU pesticide registration
- Ditch, stream and pond scenarios parameterised for TOXSWA in EU

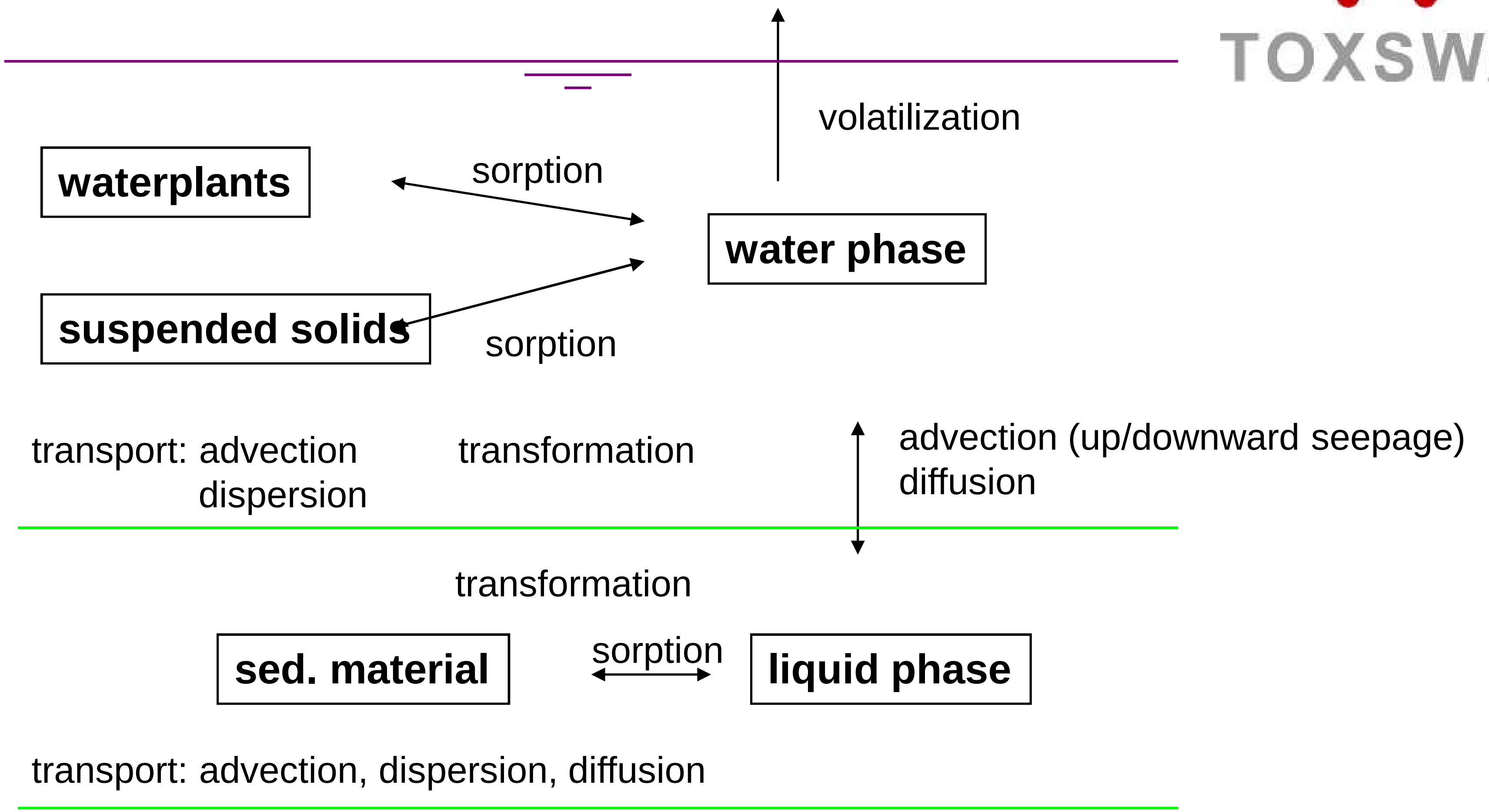
Selected models for surface water: Fate in SW



TOXSWA

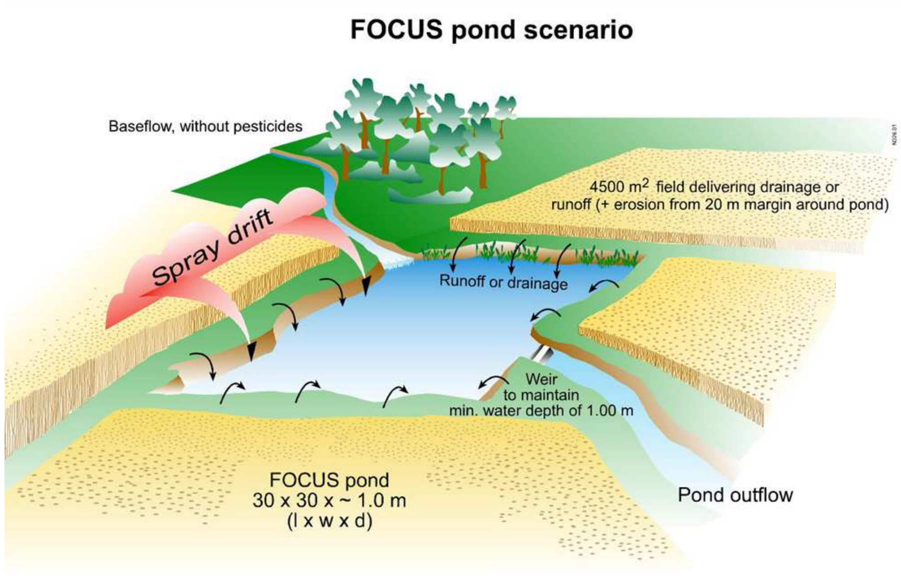
Selected models for surface water: Fate in SW

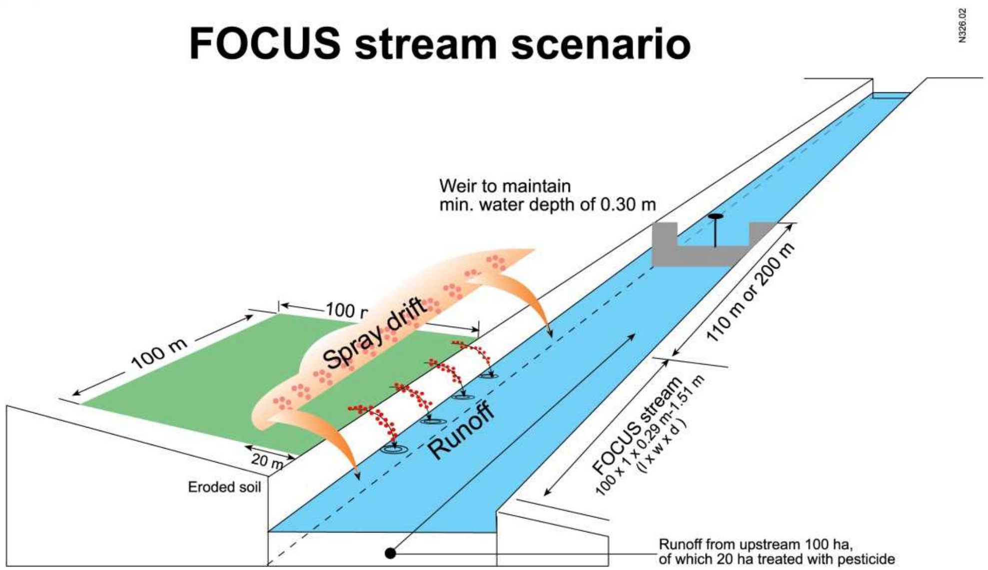
Pesticide processes simulated by TOXSWA



Selected models for surface water: Fate in SW

Ditch, stream and pond scenarios parameterised for TOXSWA in EU





Selected models for surface water: Fate in SW

Proposal for Ethiopia

- Temporary lakes
  - EU FOCUS pond properties (sediment, sus.sol, macrophytes)
  - Ethiopian lake dimensions
    - E.g. minimal dimension of lake were people and/or cattle still drink water
  - EU FOCUS pond properties (sediment, sus.sol, macrophytes)
  - Ethiopian contributing area and crops

Selected models for surface water: Fate in SW

Proposal for Ethiopia

- Stream/small rivers
  - Multiply concentration in runoff water calculated by PRZM with a dilution factor (need to be defined)