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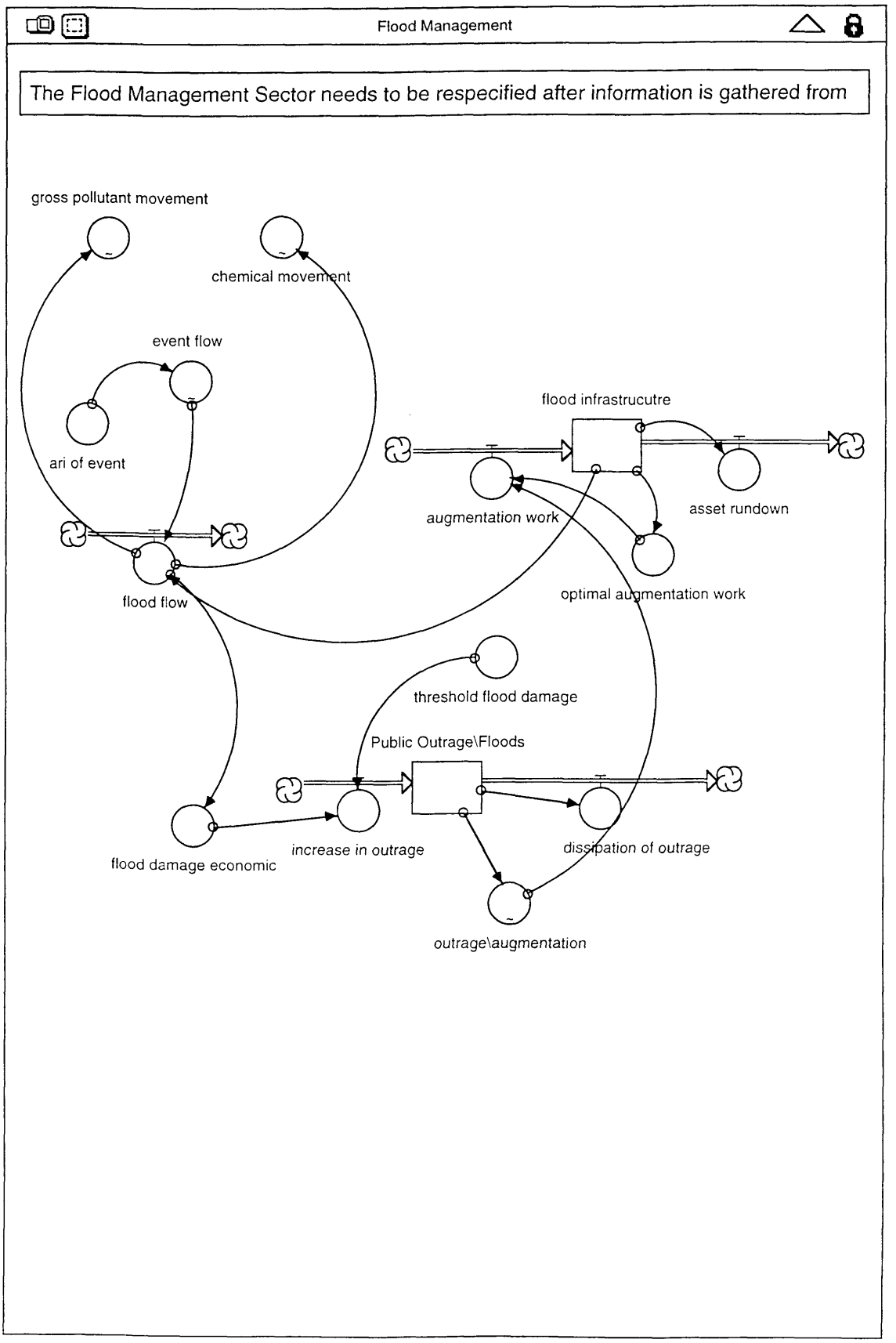
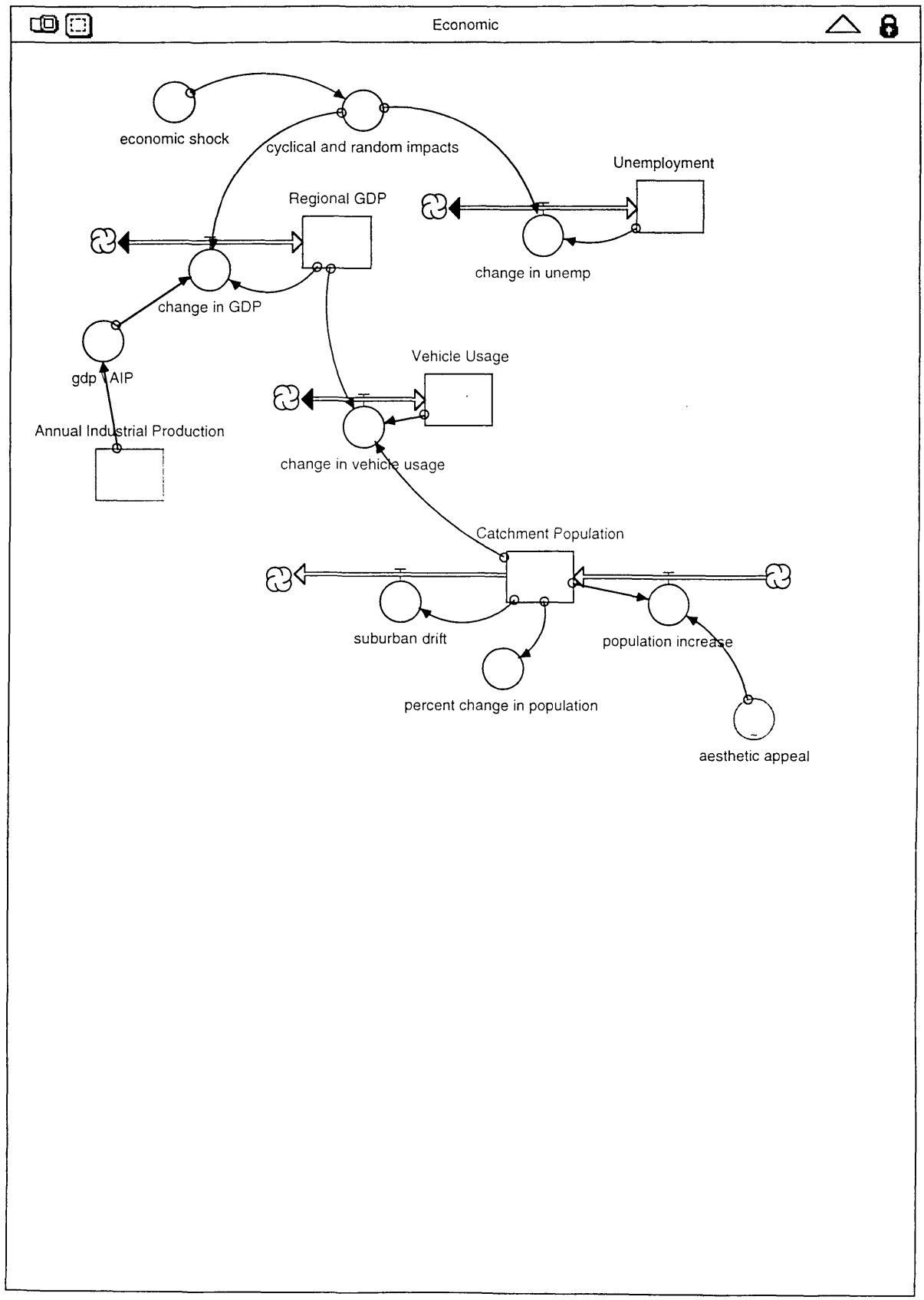
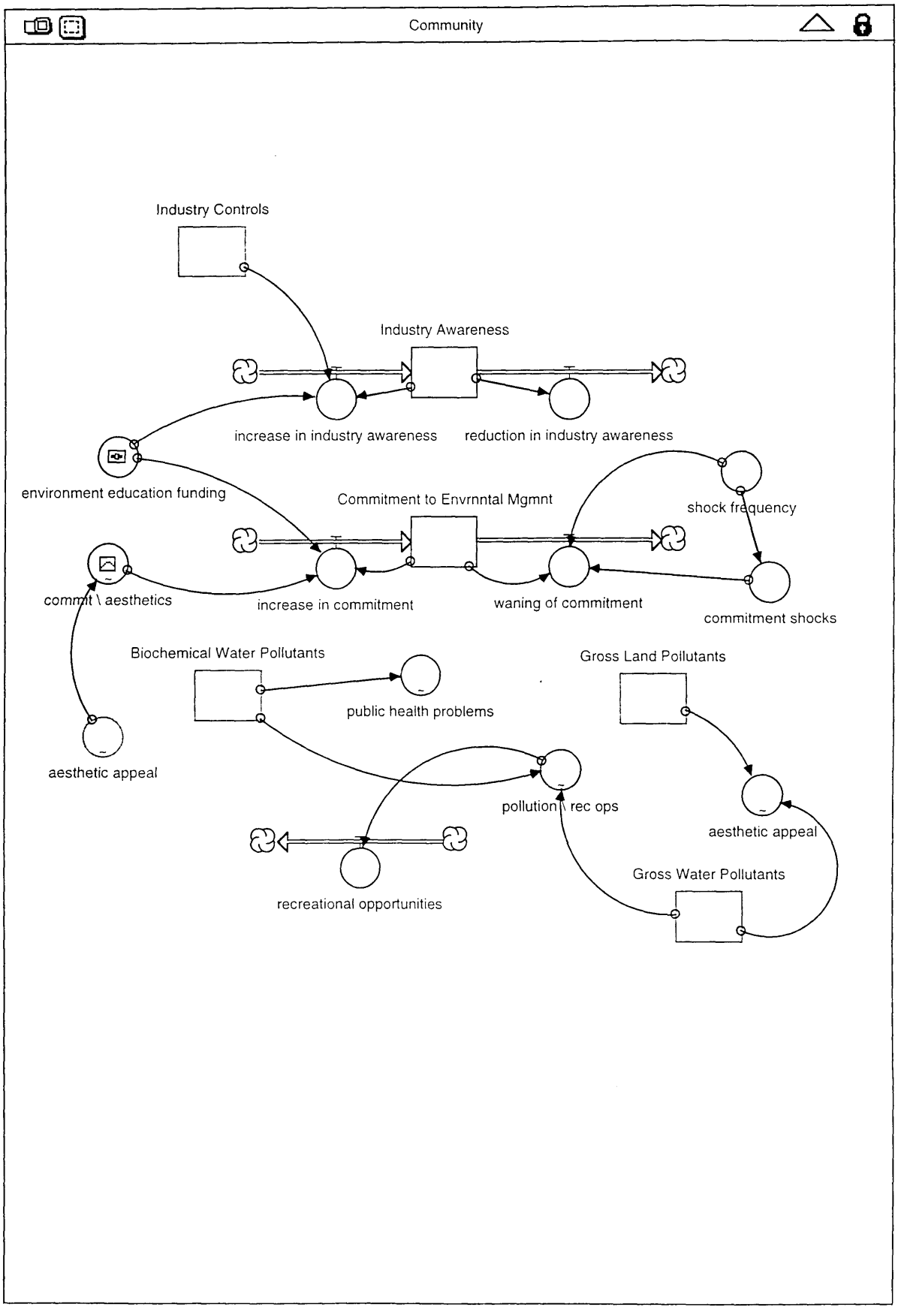
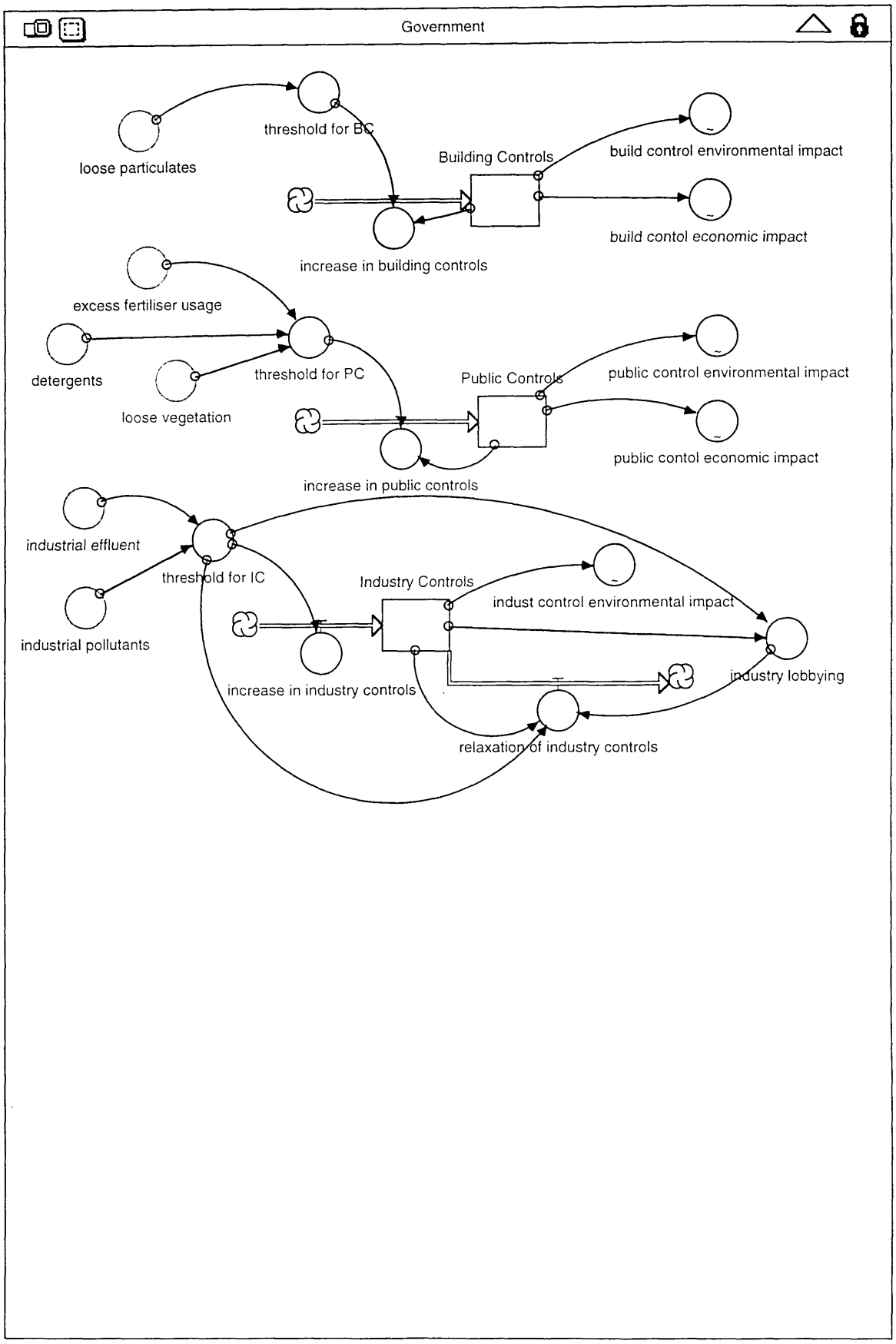
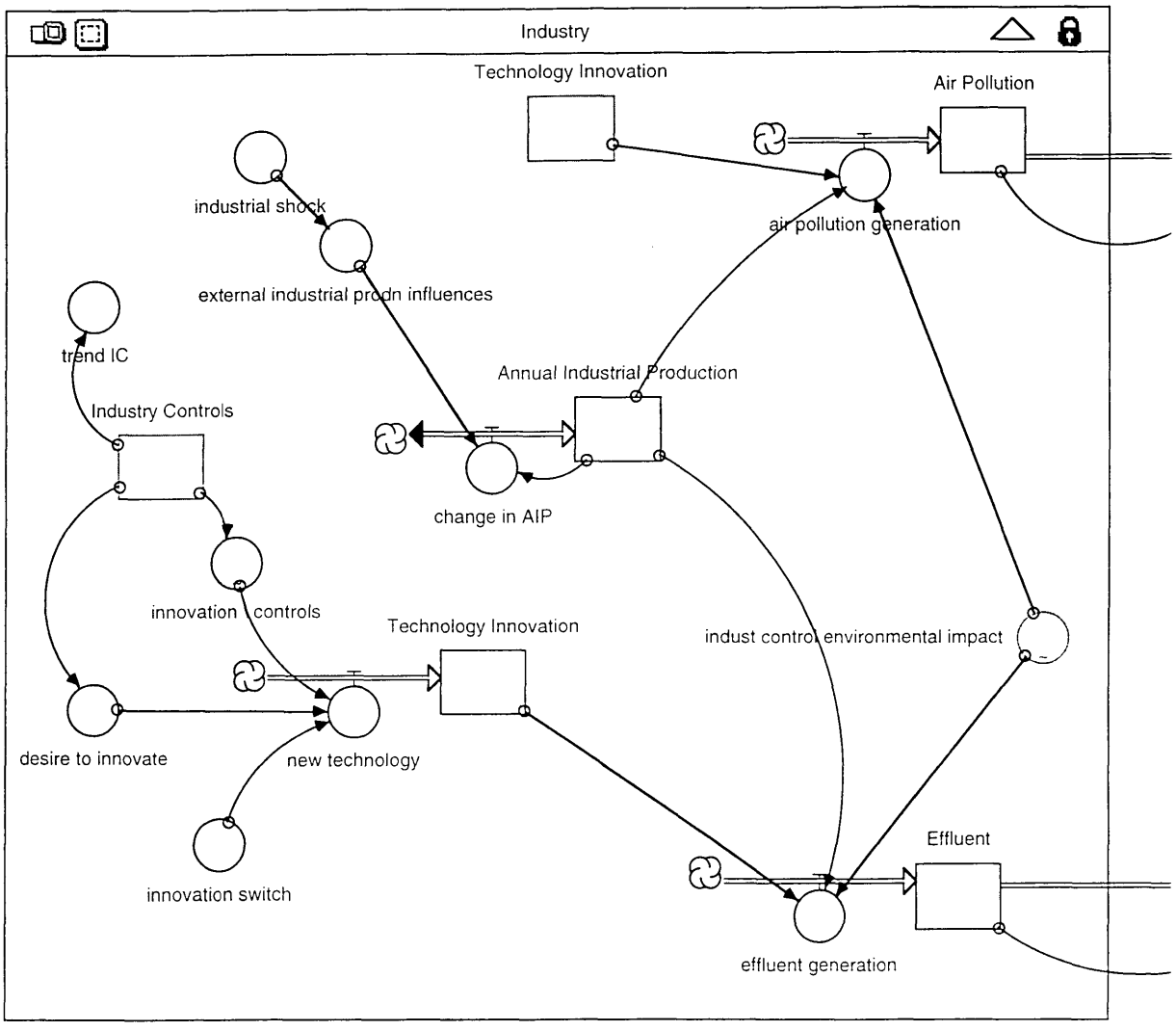
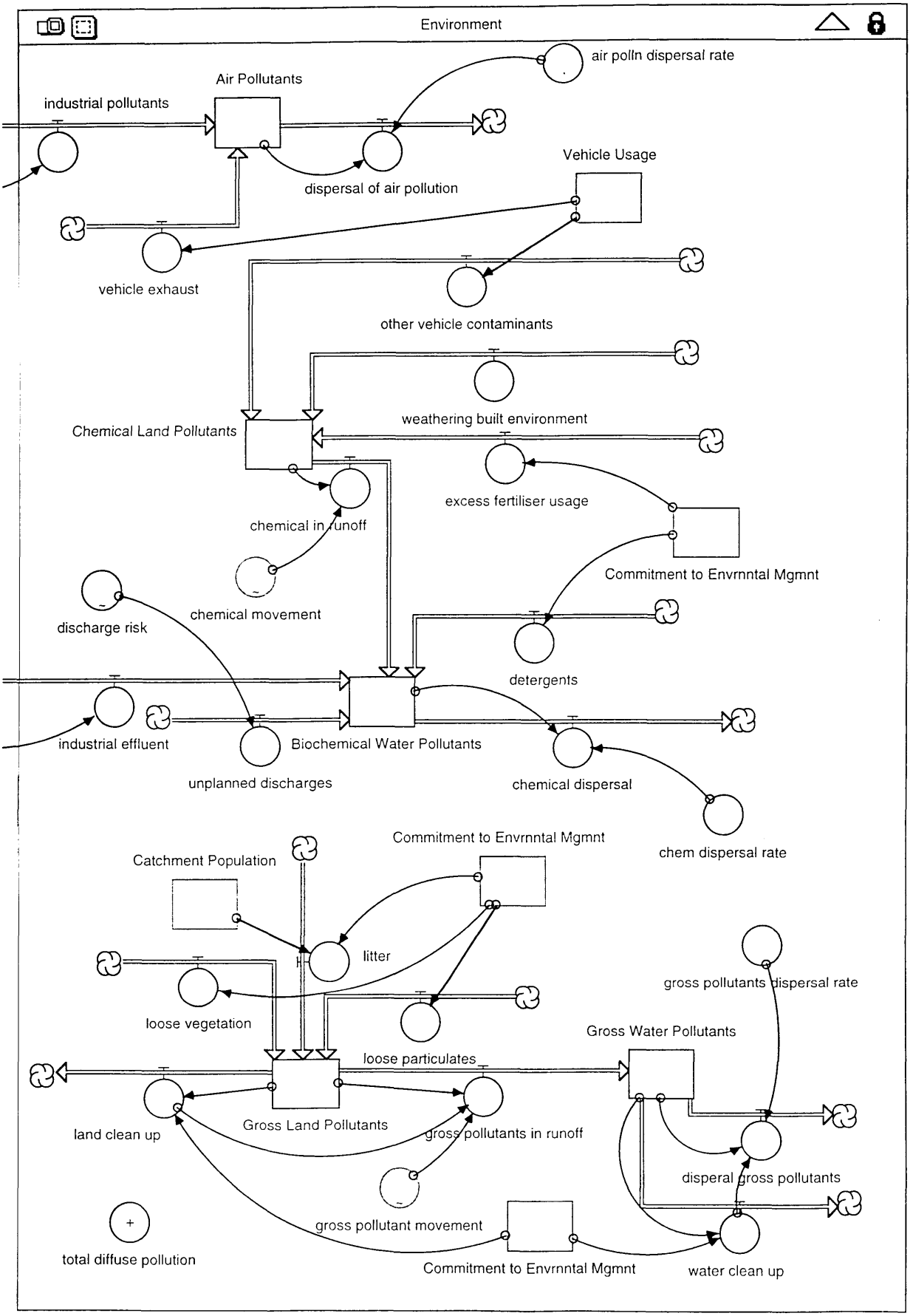

Flood Management
The Flood Management Sector needs to be respecified after information is gathered from
gross pollutant movement
chemical movement
event flow
ari of event
flood infrastrucutre
augmentation work
asset rundown
optimal augmentation work
flood flow
threshold flood damage
Public Outrage\Floods
flood damage economic
increase in outrage
dissipation of outrage
outrage\augmentation


Economic
economic shock
cyclical and random impacts
Unemployment
Regional GDP
change in unemp
change in GDP
gdp / AIP
Vehicle Usage
Annual Industrial Production
change in vehicle usage
Catchment Population
suburban drift
population increase
percent change in population
aesthetic appeal


Community
Industry Controls
Industry Awareness
increase in industry awareness
reduction in industry awareness
environment education funding
Commitment to Envrnntal Mgmnt
shock frequency
commit \ aesthetics
increase in commitment
waning of commitment
commitment shocks
Biochemical Water Pollutants
public health problems
Gross Land Pollutants
aesthetic appeal
pollution \ rec ops
aesthetic appeal
Gross Water Pollutants
recreational opportunities


Government
threshold for BC
loose particulates
Building Controls
build control environmental impact
build contol economic impact
increase in building controls
excess fertiliser usage
detergents
threshold for PC
loose vegetation
Public Controls
public control environmental impact
public contol economic impact
increase in public controls
industrial effluent
threshold for IC
industrial pollutants
Industry Controls
indust control environmental impact
industry lobbying
increase in industry controls
relaxation of industry controls


Industry
Technology Innovation
Air Pollution
industrial shock
air pollution generation
external industrial prodn influences
trend IC
Annual Industrial Production
Industry Controls
change in AIP
innovation controls
Technology Innovation
indust control environmental impact
desire to innovate
new technology
innovation switch
Effluent
effluent generation


Environment
air polln dispersal rate
Air Pollutants
industrial pollutants
dispersal of air pollution
Vehicle Usage
vehicle exhaust
other vehicle contaminants
weathering built environment
Chemical Land Pollutants
excess fertiliser usage
chemical in runoff
Commitment to Envrnntal Mgmnt
chemical movement
discharge risk
detergents
industrial effluent
Biochemical Water Pollutants
unplanned discharges
chemical dispersal
chem dispersal rate
Commitment to Envrnntal Mgmnt
Catchment Population
litter
gross pollutants dispersal rate
loose vegetation
Gross Water Pollutants
loose particulates
land clean up
Gross Land Pollutants
gross pollutants in runoff
disperal gross pollutants
gross pollutant movement
total diffuse pollution
Commitment to Envrnntal Mgmnt
water clean up

Community Sector

Commitment_to_Envrnntal_Mgmnt(t) = Commitment_to_Envrnntal_Mgmnt(t - dt) + (increase_in_commitment - waning_of_commitment) * dt

INIT Commitment_to_Envrnntal_Mgmnt = 1

INFLOWS:

increase_in_commitment = (environment_education_funding/100)*commit__aesthetics*(2.0-Commitment_to_Envrnntal_Mgmnt)*.25

OUTFLOWS:

waning_of_commitment = if (shock_frequency+delay(shock_frequency,1) = 2) then 2*commitment_shocks*Commitment_to_Envrnntal_Mgmnt else commitment_shocks*Commitment_to_Envrnntal_Mgmnt

Industry_Awareness(t) = Industry_Awareness(t - dt) + (increase_in_industry_awareness - reduction_in_industry_awareness) * dt

INIT Industry_Awareness = 1

INFLOWS:

increase_in_industry_awareness = (environment_education_funding/init(environment_education_funding)+Industry_Controls/init(Industry_Controls))/2*Industry_Awareness-Industry_Awareness

OUTFLOWS:

reduction_in_industry_awareness = Industry_Awareness*.05

commitment_shocks = shock_frequency*random(0,.7,12)

environment_education_funding = 40

shock_frequency = montecarlo(50)

aesthetic_appeal = GRAPH((Gross_Land_Pollutants/init(Gross_Land_Pollutants)+Gross_Water_Pollutants/init(Gross_Water_Pollutants))/2)

(0.00, 1.49), (0.2, 1.45), (0.4, 1.40), (0.6, 1.30), (0.8, 1.21), (1.00, 1.00), (1.20, 0.78), (1.40, 0.665), (1.60, 0.615), (1.80, 0.565), (2.00, 0.53)

commit__aesthetics = GRAPH(aesthetic_appeal)

(0.5, 0.195), (0.6, 0.555), (0.7, 0.785), (0.8, 0.93), (0.9, 0.99), (1, 1.00), (1.10, 0.97), (1.20, 0.935), (1.30, 0.89), (1.40, 0.835), (1.50, 0.79)

pollution__rec_ops =
GRAPH((Biochemical_Water_Pollutants/init(Biochemical_Water_Pollutants)+Gross_Water_Pollutants/init(Gross_Water_Pollutants))/2)

(0.00, 1.50), (0.2, 1.46), (0.4, 1.42), (0.6, 1.38), (0.8, 1.30), (1.00, 1.19), (1.20, 1.06), (1.40, 0.935), (1.60, 0.8), (1.80, 0.645), (2.00, 0.5)

public_health_problems =
GRAPH(Biochemical_Water_Pollutants/init(Biochemical_Water_Pollutants))

(0.00, 0.51), (0.2, 0.515), (0.4, 0.52), (0.6, 0.54), (0.8, 0.6), (1.00, 0.705), (1.20, 0.82), (1.40, 0.97), (1.60, 1.12), (1.80, 1.30), (2.00, 1.50)

Economic Sector

Catchment_Population(t) = Catchment_Population(t - dt) + (population_increase - suburban_drift) * dt

INIT Catchment_Population = 65840

INFLOWS:

population_increase = Catchment_Population*.005*aesthetic_appeal

OUTFLOWS:

suburban_drift = Catchment_Population*0.005

Regional_GDP(t) = Regional_GDP(t - dt) + (change_in_GDP) * dt

INIT Regional_GDP = 100

INFLOWS:

change_in_GDP = Regional_GDP*cyclical_and_random_impacts/100 + gdp__AIP

Unemployment(t) = Unemployment(t - dt) + (change_in_unemp) * dt

INIT Unemployment = 8

INFLOWS:

change_in_unemp = Unemployment*cyclical_and_random_impacts/100

Vehicle_Usage(t) = Vehicle_Usage(t - dt) + (change_in_vehicle_usage) * dt

INIT Vehicle_Usage = 1

INFLOWS:

change_in_vehicle_usage = (Catchment_Population/init(Catchment_Population) + Regional_GDP/init(Regional_GDP))/2 * Vehicle_Usage-Vehicle_Usage

cyclical_and_random_impacts = SINWAVE(1,5)+NORMAL(0,2,8)-economic_shock

economic_shock = MONTECARLO(50,7)*random(0,2,6)

gdp__AIP = trend(Annual_Industrial_Production,2)/dt*100

percent_change_in_population = (Catchment_Population-delay(Catchment_Population,1))/delay(Catchment_Population,1)*100

Environment Sector

Air_Pollutants(t) = Air_Pollutants(t - dt) + (industrial_pollutants + vehicle_exhaust - dispersal_of_air_pollution) * dt

INIT Air_Pollutants = 400

INFLOWS:

industrial_pollutants = Air_Pollution

vehicle_exhaust = Vehicle_Usage*100

OUTFLOWS:

dispersal_of_air_pollution = Air_Pollutants*air_polln_dispersal_rate

Biochemical_Water_Pollutants(t) = Biochemical_Water_Pollutants(t - dt) + (chemical_in_runoff + detergents + unplanned_discharges + industrial_effluent - chemical_dispersal) * dt

INIT Biochemical_Water_Pollutants = 250

INFLOWS:

chemical_in_runoff = Chemical_Land_Pollutants*chemical_movement

detergents = 100/Commitment_to_Envrnntal_Mgmnt

unplanned_discharges = 100*discharge_risk

industrial_effluent = Effluent

OUTFLOWS:

chemical_dispersal = Biochemical_Water_Pollutants*chem_dispersal_rate/dt

Chemical_Land_Pollutants(t) = Chemical_Land_Pollutants(t - dt) + (excess_fertiliser_usage + other_vehicle_contaminants + weathering_built_environment - chemical_in_runoff) * dt

INIT Chemical_Land_Pollutants = 750

INFLOWS:

excess_fertiliser_usage = 100/Commitment_to_Envrnntal_Mgmnt

other_vehicle_contaminants = Vehicle_Usage*100

weathering_built_environment = 100

OUTFLOWS:

chemical_in_runoff = Chemical_Land_Pollutants*chemical_movement

Gross_Land_Pollutants(t) = Gross_Land_Pollutants(t - dt) + (litter + loose_vegetation + loose_particulates - gross_pollutants_in_runoff - land_clean_up) * dt

INIT Gross_Land_Pollutants = 450

INFLOWS:

litter = 100*Catchment_Population/init(Catchment_Population)/Commitment_to_Envrnntal_Mgmnt

loose_vegetation = 100/Commitment_to_Envrnntal_Mgmnt

loose_particulates = 100/Commitment_to_Envrnntal_Mgmnt

OUTFLOWS:

gross_pollutants_in_runoff = (Gross_Land_Pollutants-land_clean_up)*gross_pollutant_movement/dt

land_clean_up = Gross_Land_Pollutants/5*Commitment_to_Envrnntal_Mgmnt

Gross_Water_Pollutants(t) = Gross_Water_Pollutants(t - dt) + (gross_pollutants_in_runoff - water_clean_up - disperal_gross_pollutants) * dt

INIT Gross_Water_Pollutants = 150

INFLOWS:

gross_pollutants_in_runoff = (Gross_Land_Pollutants-land_clean_up)*gross_pollutant_movement/dt

OUTFLOWS:

water_clean_up = Gross_Water_Pollutants/5*Commitment_to_Envrnntal_Mgmnt

disperal_gross_pollutants = (Gross_Water_Pollutants-water_clean_up)*gross_pollutants_dispersal_rate

air_polln_dispersal_rate = .5

chem_dispersal_rate = .5

gross_pollutants_dispersal_rate = .5

total_diffuse_pollution = Biochemical_Water_Pollutants + Air_Pollutants + Chemical_Land_Pollutants + Gross_Land_Pollutants + Gross_Water_Pollutants

discharge_risk = GRAPH(random (0,1,1))

(0.00, 0.00), (0.1, 0.00), (0.2, 0.03), (0.3, 0.06), (0.4, 0.105), (0.5, 0.185), (0.6, 0.27), (0.7, 0.405), (0.8, 0.59), (0.9, 0.79), (1, 1.00)

Flood Management Sector

flood_infrastrucutre(t) = flood_infrastrucutre(t - dt) + (augmentation_work - asset_rundown) * dt

INIT flood_infrastrucutre = 1

INFLOWS:

augmentation_work = optimal_augmentation_work*outrage\augmentation

OUTFLOWS:

asset_rundown = flood_infrastrucutre*.02

Public_Outrage\Floods(t) = Public_Outrage\Floods(t - dt) + (increase_in_outrage - dissipation_of_outrage) * dt

INIT Public_Outrage\Floods = 1

INFLOWS:

increase_in_outrage = if(flood_damage_economic>threshold_flood_damage) then flood_damage_economic else 0

OUTFLOWS:

dissipation_of_outrage = if(Public_Outrage\Floods>1) then Public_Outrage\Floods*0.4 else 0

ari_of_event = poisson(50,10)/dt

flood_damage_economic = if(flood_flow>5) then flood_flow^2/100 else 0

optimal_augmentation_work = flood_infrastrucutre*.1

threshold_flood_damage = 10

chemical_movement = GRAPH(flood_flow)

(0.00, 0.00), (10.0, 0.785), (20.0, 0.905), (30.0, 0.945), (40.0, 0.97), (50.0, 0.985), (60.0, 1.00), (70.0, 1.00), (80.0, 1.00), (90.0, 1.00), (100, 1.00)

event_flow = GRAPH(ari_of_event)

(1.00, 0.0977), (2.00, 0.107), (3.00, 0.117), (4.00, 0.127), (5.00, 0.137), (6.00, 0.146), (7.00, 0.156), (8.00, 0.166), (9.00, 0.176), (10.0, 0.195), (11.0, 0.215), (12.0, 0.234), (13.0, 0.254), (14.0, 0.273), (15.0, 0.293), (16.0, 0.313), (17.0, 0.332), (18.0, 0.351), (19.0, 0.371), (20.0, 0.391), (21.0, 0.43), (22.0, 0.469), (23.0, 0.508), (24.0, 0.547), (25.0, 0.586), (26.0, 0.625), (27.0, 0.664), (28.0, 0.703), (29.0, 0.742), (30.0, 0.781), (31.0, 0.859), (32.0, 0.937), (33.0, 1.02), (34.0, 1.09), (35.0, 1.17), (36.0, 1.25), (37.0, 1.33), (38.0, 1.41), (39.0, 1.48), (40.0, 1.56), (41.0, 1.72), (42.0, 1.88), (43.0, 2.03), (44.0, 2.19), (45.0, 2.34), (46.0, 2.50), (47.0,

2.66), (48.0, 2.81), (49.0, 2.97), (50.0, 3.13), (51.0, 3.44), (52.0, 3.75), (53.0, 4.06), (54.0, 4.37), (55.0, 4.69), (56.0, 5.00), (57.0, 5.31), (58.0, 5.62), (59.0, 5.94), (60.0, 6.25), (61.0, 6.88), (62.0, 7.50), (63.0, 8.13), (64.0, 8.75), (65.0, 9.38), (66.0, 10.0), (67.0, 10.6), (68.0, 11.3), (69.0, 11.9), (70.0, 12.5), (71.0, 13.8), (72.0, 15.0), (73.0, 16.3), (74.0, 17.5), (75.0, 18.8), (76.0, 20.0), (77.0, 21.3), (78.0, 22.5), (79.0, 23.8), (80.0, 25.0), (81.0, 27.5), (82.0, 30.0), (83.0, 32.5), (84.0, 35.0), (85.0, 37.5), (86.0, 40.0), (87.0, 42.5), (88.0, 45.0), (89.0, 47.5), (90.0, 50.0), (91.0, 55.0), (92.0, 60.0), (93.0, 65.0), (94.0, 70.0), (95.0, 75.0), (96.0, 80.0), (97.0, 85.0), (98.0, 90.0), (99.0, 95.0), (100, 100)

gross_pollutant_movement = GRAPH(flood_flow)

(0.00, 0.00), (10.0, 0.44), (20.0, 0.635), (30.0, 0.845), (40.0, 0.905), (50.0, 0.945), (60.0, 0.965), (70.0, 0.985), (80.0, 1.00), (90.0, 1.00), (100, 1.00)

outrage\augmentation = GRAPH(Public_Outrage\Floods)

(0.00, 0.00), (10.0, 0.57), (20.0, 0.81), (30.0, 0.99), (40.0, 1.18), (50.0, 1.38), (60.0, 1.51), (70.0, 1.64), (80.0, 1.79), (90.0, 1.90), (100, 1.99)

Government Sector

Building_Controls(t) = Building_Controls(t - dt) + (increase_in_building_controls) * dt

INIT Building_Controls = 1

INFLOWS:

increase_in_building_controls = if(delay(threshold_for_BC,1,0)>1) then Building_Controls*.1 else 0

Industry_Controls(t) = Industry_Controls(t - dt) + (increase_in_industry_controls - relaxation_of_industry_controls) * dt

INIT Industry_Controls = 1

INFLOWS:

increase_in_industry_controls = if(delay(threshold_for_IC,1,0)>1) then .1 else 0

OUTFLOWS:

relaxation_of_industry_controls = if(trend(threshold_for_IC,4) < 0) then (if(industry_lobbying=1) then .15*Industry_Controls else 0) else 0

Public_Controls(t) = Public_Controls(t - dt) + (increase_in_public_controls) * dt

INIT Public_Controls = 1

INFLOWS:

increase_in_public_controls = if(delay(threshold_for_PC,1,0)>1) then Public_Controls*.1 else 0

industry_lobbying = (if (trend(Industry_Controls,4) > .01) then 1 else 0)* (if(threshold_for_IC <1) then 1 else 0)

threshold_for_BC = loose_particulates/init(loose_particulates)

threshold_for_IC = (industrial_effluent/init(industrial_effluent)+industrial_pollutants/init(industrial_pollutants))/2

threshold_for_PC = (detergents/init(detergents)+excess_fertiliser_usage/init(excess_fertiliser_usage)+loose_vegetation/init(loose_vegetation))/3

build_contol_economic_impact = GRAPH(Building_Controls)

(1.00, 0.00), (1.90, 0.025), (2.80, 0.05), (3.70, 0.08), (4.60, 0.11), (5.50, 0.14), (6.40, 0.2), (7.30, 0.295), (8.20, 0.45), (9.10, 0.69), (10.0, 1.00)

build_control_environmental_impact = GRAPH(Building_Controls)

(0.00, 0.00), (1.00, 0.28), (2.00, 0.51), (3.00, 0.635), (4.00, 0.73), (5.00, 0.8), (6.00, 0.85), (7.00, 0.895), (8.00, 0.935), (9.00, 0.97), (10.0, 1.00)

indust_control_environmental_impact = GRAPH(Industry_Controls)

(1.00, 1.00), (1.90, 0.99), (2.80, 0.97), (3.70, 0.93), (4.60, 0.885), (5.50, 0.81), (6.40, 0.73), (7.30, 0.63), (8.20, 0.495), (9.10, 0.315), (10.0, 0.075)

public_contol_economic_impact = GRAPH(Public_Controls)

(1.00, 0.00), (1.90, 0.025), (2.80, 0.05), (3.70, 0.08), (4.60, 0.11), (5.50, 0.14), (6.40, 0.2), (7.30, 0.295), (8.20, 0.45), (9.10, 0.69), (10.0, 1.00)

public_control_environmental_impact = GRAPH(Public_Controls)

(0.00, 0.00), (1.00, 0.28), (2.00, 0.51), (3.00, 0.635), (4.00, 0.73), (5.00, 0.8), (6.00, 0.85), (7.00, 0.895), (8.00, 0.935), (9.00, 0.97), (10.0, 1.00)

Industry Sector

Air_Pollution(t) = Air_Pollution(t - dt) + (air_pollution_generation - industrial_pollutants) * dt

INIT Air_Pollution = 100

INFLOWS:

air_pollution_generation = Annual_Industrial_Production*indust_control_environmental_impact/Technology_Innovation

OUTFLOWS:

industrial_pollutants (IN SECTOR: Environment)

Annual_Industrial_Production(t) = Annual_Industrial_Production(t - dt) + (change_in_AIP) * dt

INIT Annual_Industrial_Production = 100

INFLOWS:

change_in_AIP = external_industrial_prodn_influences/100*Annual_Industrial_Production+1

Effluent(t) = Effluent(t - dt) + (effluent_generation - industrial_effluent) * dt

INIT Effluent = 100

INFLOWS:

effluent_generation = Annual_Industrial_Production/indust_control_environmental_impact/Technology_Innovation

OUTFLOWS:

industrial_effluent (IN SECTOR: Environment)

Technology_Innovation(t) = Technology_Innovation(t - dt) + (new_technology) * dt

INIT Technology_Innovation = 1

INFLOWS:

new_technology = montecarlo(innovation__controls,5)*random(.05,.2,5)*desire_to_innovate*innovation_switch

desire_to_innovate = if TREND(Industry_Controls,4) > 0 then 1 else 0

external_industrial_prodn_influences = sinwave(2,7)+NORMAL(0,.5,3)+industrial_shock

industrial_shock = montecarlo(50,1)*normal(-2,10,2)

innovation_switch = 1

trend_IC = trend (Industry_Controls,4)

innovation__controls = GRAPH(Industry_Controls)

(0.00, 5.00), (0.5, 21.6), (1.00, 36.4), (1.50, 53.0), (2.00, 63.9), (2.50, 74.8), (3.00, 84.3), (3.50, 89.1), (4.00, 93.3), (4.50, 98.1), (5.00, 100)

Category A: The Blurring and Melding of Disciplinary Boundaries

Indicators

1. Does this work go beyond normal conceptions of scientific disciplines?
2. Does this work attempt to integrate and synthesise many different disciplinary perspectives?
3. Is there an attempt to make use of a language of universal transparency, or a common metaphor, in order to facilitate transdisciplinary communication?
4. Is the approach problem-focussed rather than being constrained within disciplinary boundaries?
5. Are there any explicit or implicit generalised axioms that underlie the work? Is the work consistent with the generalised axioms of ecological economics? (The second question should only be applied to work that is purportedly ecological economics).
6. Is the integration left to the reader, or is it explicitly addressed in the project?

Contra-indicators

7. Is the work based firmly on a home discipline, where perspectives from other disciplines provide qualification for, or enrichment of, the focussed work within a particular discipline? (This would indicate multidisciplinarity).
8. Is there evidence of the transfer of methods from one discipline to another? (This would indicate interdisciplinarity).

Category B: The Use of a Systems Approach

Indicators

1. Is there a systems perspective in which developing understanding about the links between system components is emphasised?
2. Are there mechanisms to make more complex structures comprehensible?
3. Is there a mechanism to structure the work so that the different hierarchical levels of the work are systematically articulated? Does this allow for different goals at different levels, and that the overall system goal may be fundamentally different to those of the different levels?.

Contra-indicators

4. Is duality a key aspect of the work? E.g. yes/no, wrong/right, black/white etc.
5. Is there an attempt to reduce reality to a single level?
6. Is there a focus on concrete, short term gains?

Category C: The Search for Synergistic Opportunities

Indicators

1. Is there evidence of a synergistic alliance between and across conventional disciplinary boundaries?

2. Is there an explicit attempt to capture synergy in the outcomes?
3. Does the work involve an inclusive, participative style?

Contra-indicators

4. Is the work predicated upon a confrontational and argumentative adversarial style?

Category D: The Harnessing of Creative Tension

Indicators

1. Can the approach cope with philosophical diversity?
2. Are there checks and balances to ensure that no particular methodological approach dominates?
3. Are minority views likely to be properly represented?
4. Can inconsistency, incommensurability and paradox be accepted and dealt with in a meaningful way?