ZOL 814
Chemodynamics

Generic Expected Environmental Concentration Program (GENEEC)

Name:_____

Background:

The **GENEEC** model is used to calculate the Expected Environmental Concentration (EEC) for a generic aquatic pond environment adjacent to an agricultural field. The simulation provided an analytical tool to assess the potential for adverse effects of pesticides on adjacent aquatic environments. This is not a predictive tool, but rather used in a conservative Tier I risk assessment. See the users manual for earlier versions (on diskette) for a more detailed description of the model. There is no user manual for the beta version 1.3 (most recent version) that we will be using in class.

GENEEC version 1.3 mimics a PRZM/EXAMS simulation of a generic 10-ha row crop field draining into a 1-ha farm pond of depth 1 m. It also incorporates the Tier 1 spray drift model of the U.S. Spray Drift Task Force to provide an estimate of spray drift loading. The model contains numerous conservative assumptions appropriate for a screening level model. One aspect of this generic model that prevents realistic simulation of late-season foliar applications is that it does not take into account foliage factors such as interception of spray, foliar dissipation prior to rainfall, or pesticide wash-off fraction. The predicted generic concentrations should not be interpreted as accurate estimates; instead they are merely screening levels (upper bound estimates).

In this exercise we will estimate the environmental concentrations of the organophosphorus insecticide, chlorpyrifos used in cotton under Australia conditions. Application information for this example was provided by Dr. Paul Hughes, Dow AgroSciences, Australia. Chemical properties and environmental fate parameters were

taken from the United States Department of Agriculture Agricultural Research Service Pesticide Properties Database. This database has been subjected to peer review by registrants but has not been updated recently. However, it is judged to be a reasonably accurate compilation of data, and representative values provided in the database are based on objective, unbiased selection procedures. Aquatic degradation half-lives for all the processes accounted for in GENEEC (aerobic degradation, hydrolysis, and photolysis) are not uniformly available for all of the compounds in the database. In this example field-estimated lumped first-order dissipation from the water column was entered arbitrarily as a rate for aerobic degradation. USEPA prefers laboratory values for individual processes.

Below you will find the individual screens that will appear when you execute the model. Follow these and input the data into the model. When you have completed the simulation, your instructors will assist you in interpreting the information and discuss how it is used in a Tier I ecological risk assessment.

Use GENEEC to simulate the concentration of chlorpyrifos that would be expected to occur in a pond near a cotton field treated with chlorpyrifos. The model can be found at the course website: http://www.msu.edu/course/zol/814. Download the model onto your computer. To run the model, get a dos prompt and type "GENEECX" at the prompt. Below are the input screens that you will see when making inputs (parameterizing) into the model. After you run the model, answer the questions.

```
                         VERSION 1.3

              ENVIRONMENTAL FATE AND EFFECTS DIVISION
                    OFFICE OF PESTICIDE PROGRAMS
                 U.S. ENVIRONMENTAL PROTECTION AGENCY


                      TIER ONE SCREENING MODEL
                  FOR AQUATIC PESTICIDE EXPOSURE

                        BETA TEST VERSION

                     PLEASE FAX COMMENTS TO:

                   RON PARKER (703) 305-6309



PLEASE CHOOSE THE LETTER OF THE APPLICATION YOU WISH TO USE:

A: ROW CROPS, ORCHARDS, GRASSES AND TURF
B: RICE
C: CRANBERRIES
D: DITCHBANKS AND RIGHTS-OF-WAY ---> A
```

```
                           GENEEC

               FOR ROWCROPS, ORCHARDS AND TURF


              ENVIRONMENTAL FATE AND EFFECTS DIVISION
                    OFFICE OF PESTICIDE PROGRAMS
                 U.S. ENVIRONMENTAL PROTECTION AGENCY


                      TIER ONE SCREENING MODEL
                  FOR AQUATIC PESTICIDE EXPOSURE



 THIS IS A PROGRAM TO CALCULATE A SET OF GENERIC
 ESTIMATED ENVIRONMENTAL CONCENTRATION (GEEC) VALUES
 RESULTING FROM RUNOFF FROM A TEN HECTARE FIELD INTO
 A ONE HECTARE BY TWO METER DEEP STATIC WATER BODY


 ENTER A RUN NUMBER TO CONTINUE ---> 1
```

```
ENTER AN OUTPUT FILE NAME ---> Cotton1


ENTER CHEMICAL NAME ---> Chlorpyrifos


ENTER CROP NAME ---> Cotton
```

```
  THE PROGRAM ASSUMES THAT RUNOFF IS SUFFICIENT TO REMOVE TEN
  PERCENT OF THE DISSOLVED PESTICIDE FROM THE TEN HECTARE FIELD




  THE FOLLOWING INFORMATION SHOULD BE TAKEN FROM THE MOST
  CURRENT, ACCEPTED LABEL FOR THE USE SITE IN QUESTION

  PLEASE ENTER APPLICATION RATE (IN POUNDS a.i. PER ACRE)---> 1.340


  ENTER MAXIMUM NUMBER OF APPLICATIONS PERMITTED PER YEAR---> 2


  ENTER INTERVAL BETWEEN APPLICATIONS (DAYS)---> 10
```

```
THE DISSOLVED PESTICIDE CONCENTRATION IS REDUCED BY
ADSORPTION OF THE PESTICIDE TO SOIL OR TO ORGANIC MATTER

THE ADSORBED FRACTION IS ESTIMATED BY THE SOIL/WATER
EQUILIBRIUM PARTITION COEFFICIENT (Kd)




PLEASE ENTER Kd VALUE (WITHOUT COMMAS)---> 115
```

```
THE DISSOLVED PESTICIDE CONCENTRATION IS ALSO REDUCED
BY DEGREDATION IN THE FIELD PRIOR TO A RAINFALL/RUNOFF
EVENT - THE PROGRAM ASSUMES DEGRADATION BY AEROBIC
METABOLISM FOR TWO DAYS AFTER THE FINAL APPLICATION



(IF STABLE TO AEROBIC METABOLISM OR IF DATA IS
UNAVAILABLE, PLEASE ENTER ZERO (0))


ENTER SOIL AEROBIC METABOLIC HALFLIFE (IN DAYS) ---> 30.5
```

```
SOME PESTICIDE LABELS REQUIRE THAT THE PESTICIDE BE
WETTED-IN EITHER THROUGH RAINFALL OR IRRIGATION:


IN THIS CASE, RUNOFF TO THE POND IS ASSUMED TO OCCUR
IMMEDIATELY RATHER THAN AFTER TWO DAYS

IS THIS PESTICIDE TO BE WETTED-IN ?  (Y or N) ---> N
```

```
THE DISSOLVED PESTICIDE CONCENTRATION MAY BE INCREASED
BY DIRECT DEPOSITION OF SPRAY DRIFT INTO THE POND


ENTER A, B or C TO SELECT METHOD OF APPLICATION:
A: AERIAL SPRAY
B: GROUND SPRAY
C: GRANULAR (NON-SPRAY) ---> A
```

```
SPRAY DRIFT TO THE POND MAY BE REDUCED BY A BUFFER ZONE
LOCATED BETWEEN THE TREATED FIELD AND THE WATER BODY


PLEASE ENTER THE WIDTH OF THE SPRAY DRIFT BUFFER (FEET)
(FOR NO BUFFER, ENTER ZERO (0) ---> 49.2
```

```
THE DISSOLVED PESTICIDE CONCENTRATION IN A WATER
BODY CANNOT EXCEED THE SOLUBILITY OF THE CHEMICAL


ENTER THE SOLUBILITY (IN PPM) ---> 1.2
```

```
CHRONIC GENERIC EEC VALUES ARE CALCULATED BY SUMMING
THE RATES OF THE AQUATIC DEGRADATION PATHWAYS




ENTER ANY OR ALL OF THE FOLLOWING WHICH ARE AVAILABLE:

(PLEASE ENTER ZERO (0) FOR ANY WHICH ARE STABLE OR
FOR WHICH VALUES ARE UNAVAILABLE)

AEROBIC AQUATIC METABOLIC HALFLIFE (DAYS) ---> 9


ENTER PHOTOLYSIS HALFLIFE (DAYS) ---> 0
```
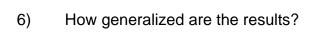
```
RUN No.   1 FOR Chlorpyrifos     ON   Cotton         * INPUT VALUES *
  -------------------------------------------------------------------
   RATE (#/AC)     APPLICATIONS   SOIL   SOLUBILITY  BUFFER(FT)  INCORP
   ONE(MULT)       NO.-INTERVAL   Kd     (PPM )      % DRIFT   DEPTH(IN)
  -------------------------------------------------------------------
 1.340(  2.408)   2   10          115.0    1.2      49.2- 11.1   0.0


 FIELD AND STANDARD POND HALFLIFE VALUES (DAYS)
  -------------------------------------------------------------------
 METABOLIC   DAYS UNTIL  HYDROLYSIS   PHOTOLYSIS    METABOLIC  COMBINED
  (FIELD)    RAIN/RUNOFF   (POND)     (POND-EFF)     (POND)     (POND)
  -------------------------------------------------------------------
   30.50         2          N/A       0.00-   0.00    9.00       9.00


 GENERIC EECs (IN PPB )
  ------------------------------------------------------------
    PEAK        AVERAGE 4     AVERAGE 21    AVERAGE 56
    GEEC        DAY GEEC      DAY GEEC      DAY GEEC
  ------------------------------------------------------------
   11.01         8.68          2.93          1.17


 DO YOU WANT ANOTHER RUN (Y OR N) --->
```

Questions:

1) What is the estimated What is the estimated environmental concentration (EEC?

2) If the No Observable Effect Concentration (NOEC) for chlorpyrifos is 5 ug/l would adverse effects be expected based on this scenario?

3) Chlorpyriphos is an organo-phosphate insecticide that is acutely toxic by depressing achetylcholinesterase (AchE) activity in the brain. It has a low acute to chronic ration. For these reasons which of the EEC values generated by GENEEC would be the most appropriate to which to compare a threshold for effects concentration?

4) What assumptions are made in this model?

5) How accurate is the model?

6)   How generalized are the results?

7)   What are the most important parameters in the model?

8)   How could the model predictions be improved?

9)   Draw the structure of the model.

10)   Perform a sensitivity analysis for the Kd value. To do this, run several
        simulations with a range of values for Kd. How sensitive is the model to
        values used for Kd?