

**The examination of aquatic organisms risk
trend on the Pesticides for paddy field
estimated by the OECD risk indicator
models in Japan**

Katsuya Sato

**Agricultural Chemicals Inspection Station (ACIS)
INDEPENDENT ADMINISTRATIVE INSTITUTION
JAPAN**

In Japan, paddy fields account for approximately 50% of all cultivated land. This means that paddy rice is the major crop in Japanese agricultural productions, and this is the very specific situation compared to the other OECD countries. Furthermore, the climate condition of Japan is also specific, namely high temperature and humidity, and this conditions lead to frequent and significant occurrence of pests and weed in paddy fields. These situations show that the effective use of pesticides in paddy fields is very useful and effective way for farmers to get stable harvest and income and this makes them free from the heavy work for weeding.

On the contrary, due to its nature, paddy field directly borders on water body. Therefore, the application of pesticides has been properly regulated to protect fisheries organisms under the provisions of “Agricultural Chemicals Regulation Law” over 30 years in Japan. In addition, public concern with respect to the conservation of environment and sustainable development of agriculture are getting higher, the reduction of the risks caused by agrochemical and fertilizer (e.g. agrochemical changing from high hazard to low hazard and application of IPM (Integrated Pest Management)) has been considered.

At present, there is no appropriate system to trace the trend of the total risk of pesticides in Japan. So we tried to examine the risk trend on the pesticides for paddy field to aquatic organisms by the OECD risk indicator models on the basis of the above things, as first trial.

1. Japanese trial level

It was tried to calculate and analyze the risk trend for 10 years of herbicide and pesticides on some main pests (rice blast disease and plant hopper) in paddy fiends using two scoring models (see bellow:).

The term for the trace of the risk

10 years from 1989 to 1998

Target crops

Rice

Paddy field in Japan was focused and the risk trends on aquatic organisms was examined, because of the following reasons:

- The paddy fields account for approximately 50% of all cultivated land in Japan.
- Rice is cultivated in all over Japan.
- The concern of outflow of pesticides from paddy fields to water body seems to be higher than from other fields.
- It may be easy to calculate the risk.

- It is easy to collect data, necessary to calculate risks, such as basic area treated and cumulative area treated on each main pest.

Target pesticide

Pesticides registered for the application for rice were used.

Type of pesticide data

The sales data from formulated products were used.

Insecticide is Top 30 on the basis of the formulated products for plant hopper and ground spray.

Fungicide is Top 30 on the basis of the formulated products for rice blast disease and ground spray.

Mixture of insecticide and fungicide is Top 30 on the basis of the formulated products for plant hopper, rice blast disease and ground spray.

Herbicide is top 30 on the basis of the formulated products for ground spray.

The use data of each active ingredient was calculated with the sales data and the rate of content of the active ingredient in the formulated product.

In this case, there were some formulated products also applied to other crops (e.g. vegetable, wheat etc.). But this time, we defined the amount of sales as the amount of use for rice; we therefore didn't take other crops into account in the application.

Area covered

The whole country

Area treated

There is no accurate area treated on each pesticide in Japan. So the area treated of each pesticide was estimated with the total area treated for plant hopper or rice blast disease and the rate of the sales amount of each formulated product to the total of the Top 30 in each category in each year. But in herbicide, the total rice planting area was used for the area treated.

Toxicity data

Acute toxicity (Fish (common carp): LC50 (48hr), *Daphnia.sp* : LC50 (3hr))

Because of following reasons:

- These data are available on these pesticides (include the values of literature).
- Acute toxicity for algae and long-term toxicity for 3 organisms were insufficient.
- The data of the pesticides provided by CSL were not almost available.

Number of indicators

“ADSCOR” and “SYSCOR” were used to try.

REXTOX as mechanistic model wouldn't be tried. Because we are now developing "Simulation model of drift and run off from paddy fields corresponding to Japanese specific conditions", but it has not been completed yet.

2. Additional information in Model kernel on OECD aquatic risk indicator computer system

85 pesticides information for rice was added in the pesticide table in Model kernel. Rice and region information were also put into the relevant tables respectively.

The breakpoint of score for rice just used the original in Model kernel.

As to buffer zone, 1m width of buffer zone of drift and run off was temporarily considered.

3. Information on collecting 85 pesticide data

Table 1 shows the rate of collection on each variable of 85 pesticides.

These data were collected from not only submitted data but also literature.

4. The movement of the total amount of estimated use of active ingredient on each pesticide group.

On the basis of the total amount of estimated use of active ingredient on each group, the trend for 10 years was investigated (Figure 1).

Herbicide showed that the amount was decreased for 10 years, and the one of 1998 was the half of 1989. The reason would come from the promotion of herbicide of low amount and high effect for 10 years.

Insecticide also showed the some decrease for 10 years.

But fungicide didn't show a movement like herbicide and insecticide for 10 years.

5. The result of Japanese pilot testing of the indicators

ADSCOR

Unscaled ADSCOR

The trend of the risk to fish and *Daphnia* on unscaled ADSCOR for 10 years was shown in figure 2.

The result showed that the risk trend to *Daphnia* was higher than fish and the trend had been decreasing over the course of the test except 1997.

Figure 3 is the result of the risk trend of them on each pesticide group.

The highest risk trend to *Daphnia* was caused by insecticide and the trend for 10 years was similar to the one to *Daphnia* by all pesticide.

Figure 4 showed the risk trend on each pesticide group except *Daphnia* on insecticide for

reference.

The risk trend to *Daphnia* on insecticide contributed to the one to all pesticide. So to know what insecticide was contributing to the risk trend, the average risk indicator of each insecticide for 10 years was investigated, and the top3 was picked up.

Figure 5 shows the result. This time, blind name was used to pesticide for some commercial matter.

In the graph, Insect 04 was confirmed in 1989 to 1991 and 1997, and the trend was similar to the one to *Daphnia* using all pesticides on unscaled ADSCOR.

Scaled ADSCOR

The trend of the risk to fish and *Daphnia* on scaled ADSCOR for 10 years was shown in figure 6.

The result indicated that the risk trend to *Daphnia* was higher than fish and the trend had been decreasing over the course of the test.

Figure 7 was the result of the risk trend of them on each pesticide group.

As a result, the highest risk trend to *Daphnia* was caused by insecticide and the trend for 10 years was similar to the one to *Daphnia* by all pesticide.

Figure 8 is the risk trend on each pesticide group except *Daphnia* on insecticide for reference.

The risk trend to *Daphnia* by insecticide contributed to the one to all pesticide. So to know what insecticide was contributing to the risk trend, the average risk indicator of each insecticide for 10 years was investigated, and the top 3 was picked up.

Figure 9 is the graph of the risk trend of the top 3 for 10 years. In figure 9, Insect 5 was the highest in 1989 to 1991 and 1997. Insect 04 were also found on scaled ADSCOR. But the risk trend was less than Insect 05 through 10 years.

Comparison between unscaled risk trend and scaled risk trend to *Daphnia* on ADSCOR

The peak of risk indicator to *Daphnia* was found in 1997 on unscaled ADSCOR. But the peak wasn't found in 1997 on scaled ADSCOR (figure 2 and figure 6).

The difference between unscaled ADSCOR and scaled ADSCOR is due to including area treated or not.

So the comparison between the top 3 of unscaled risk indicator to *Daphnia* and the basic area treated (BAT) in 1997 was tried (Table 2). As a result, Insect 04 on unscaled type was the highest, but it was the 16th in the ranking of BAT. Insect 13 was the second on unscaled, but it was the 18th on BAT. And Insect 05 was the third on unscaled, but it was the 5th on BAT.

The result of ADSCOR

The peak of the risk indicator to *Daphnia* was found on unscaled ADSCOR in 1997. But the peak in 1997 wasn't found on scaled ADSCOR.

Insect 04 contributed to the peak in 1997. The reason was considered that Insect 04 was the highest toxicity on *Daphnia*, and the formulated products including Insect 04 was ranking in the top 30 in 1989-1991 and 1997. But the BAT of Insect 04 was small, so the peak in 1997 couldn't be found on scaled ADSCOR.

SYSCOR

The trend of the risk to fish and *Daphnia* on SYSCOR for 10 years was shown in figure 10. The result showed that the risk trend to *Daphnia* was higher than fish and the trend had been decreasing over the course of the test except in 1997.

Figure 11 is the result of the risk trend of them on each pesticide group.

As a result, the highest risk trend to *Daphnia* was caused by insecticide and the trend for 10 years was similar to the one to *Daphnia* by all pesticide.

Figure 12 is the risk trend on each pesticide group except *Daphnia* on insecticide for reference.

The risk trend to *Daphnia* by insecticide contributed to the total risk trend to all pesticide. So to know what insecticide was contributing to the result, the average risk indicator of each insecticide for 10 years was investigated, and the top 3 were picked up.

Figure 13 is the graph of the risk trend of the top 3 for 10 years. In figure 13, Insect 05 was the highest for 10 years except 1997. Insect 04 was the highest in 1997 and the second in 1989 to 1991.

The comparison between SYSCOR and scaled ADSCOR

SYSCOR is the risk indicator model taking account of area treated. But the risk trend was very similar to the result of unscaled ADSCOR.

To know what the reason was, the 10 years trend of the exposure, which was composed of the variables of the application rate, area treated, etc. was investigated on the top3 insecticides on each model (figure 14).

The exposure of Insect 04 was the lowest for 10 years on each model. But the risk indicator, which was calculated by the exposure and the toxicity of Insect 04 to *Daphnia*, was the highest in 1997 on SYSCOR.

The result of SYSCOR

The peak of the risk indicator to *Daphnia* was found in 1997. And Insect 04 contributed to the peak in 1997.

SYSCOR takes account of scale. But the risk trend by SYSCOR was similar to the result by

unscaled ADSCOR. The reasons were considered that the effect of area treated in SYSCOR was smaller than scaled ADSCOR, and it is for the difference between score of area treated on SYSCOR and direct value of area treated on ADSCOR.

The relation between the hazard of *Daphnia* and the exposure on insecticide

To make clear the relation between the hazard of *Daphnia* and the exposure on insecticide, the sequence of scatter plots of the hazard of *Daphnia* and the exposure for 10 years on insecticide was tried (figure 15). The graph in fig.15 is the scatter plot on each model. The hazard consequently showed the tendency of decrease over 10 years. And each exposure also showed the same tendency.

6. Conclusions

Japanese trial level

- Target area was the whole country.
- Target crop was rice.
- Target pest and disease were plant hopper and rice blast disease on ground spray.
- The sales data from formulated products were used for use data of active ingredient.
- The target of the sales data was the top 30 on each formulated product category (insecticide, fungicide, the mixture of insecticide and fungicide and herbicide).
- The area treated was estimated on the basis of the total area treated for pest and disease or the total rice planting area and the amount of the sales data of each formulated product.
- Fish LC50 (48hr) and *Daphnia* LC50 (3hr) were used as short-term toxicity data.

The movement of the total amount of estimated use of active ingredient on each pesticide group

- Herbicide showed that the amount was decreased for 10 years. The causes came from the promotion of herbicide of low amount and high effect for 10 years.
- Insecticide also showed the some decrease for 10 years. But fungicide didn't show the decreasing trend like herbicide and insecticide for 10 years.

Aquatic risk indicator

- The risk indicator to *Daphnia* was far higher than fish on unscaled /scaled ADSCOR and SYSCOR over 10 years.
- The result depended on the risk indicator to *Daphnia* on insecticide, which was the highest in each pesticide group.
- The risk trend to *Daphnia* was decreased over 10 years on scaled ADSCOR, unscaled

ADSCOR except 1997 and SYSCOR except 1997.

The risk indicator to *Daphnia* in 1997

- The peak of risk indicator to *Daphnia* in 1997 was found from the result of two indicator's models.
- This peak came from Insect 04 (one active ingredient of insecticide).
- The causes were that the formulated product in which the content of insect 04 was very high ranked in top 30 in 1997, and in addition, the toxicity of Insect 04 to *Daphnia* was extremely high.

The relation between the hazard of *Daphnia* and the exposure on insecticide

- As a result of the sequence of scatter plots of hazard of *Daphnia* and the exposure from each model for 10 years, the tendency of reduction of hazard and each exposure for 10 years was observed.

7. Lesson and learned

In Japan, the risk trend on pesticides has never been investigated by using indicator to date, and this risk indicator calculation was first trial.

As a result, some observations were obtained, but the following would be necessary for further consideration:

About the collection of variables

- More actual data of the amount of use of pesticides on each crop.
Pesticide applies to several crops. So it is difficult to obtain the actual rate of the application to each crop.
More consideration on use data of pesticide would be necessary to obtain more actual risk indicator.
- More actual data of the area treated of pesticides on each crop, pest and disease.
- The consideration of appropriate breakpoint of score for rice in Japan on ADSCOR would be necessary.
- Some variables of pesticide to calculate the risk indicator were collected; another information was lacked (e.g. Soil information to estimate DT50 (soil) wasn't made clear whether paddy field soil or not, etc.). So it would be necessary to obtain more detail information.

About indicator models

- As a result of comparison between the Japanese results on scaled ADSCOR and SYSCOR, scaled ADSCOR seems to be more suitable for scaled risk. Because the result of SYSCOR was similar to unscaled ADSCOR.
- REXTOX would be suitable for calculate more real risk indicator in limited area. But in Japan, the scale of each field was too small and it would be finally difficult to calculate and aggregate these local risk indicators on REXTOX.
- Paddy field is specific situation such as the form of application and water management. So additional consideration would be needed to obtain the risk indicator for paddy field.

Table 1. The rate of collection of each variable on 85 pesticides

Variable	The rate of collection
Fish LC50(48hr)	100%
Daphnia LC50(3hr)	100%
Water solubility	95%
DT50(water)	96%
DT50(soil)	96%
Photolysis	94%
LogKow	93%
Koc	Non collection
Kd	Non collection

Figure 1. The trend of the total amount of estimated use on each pesticide group for 10 years

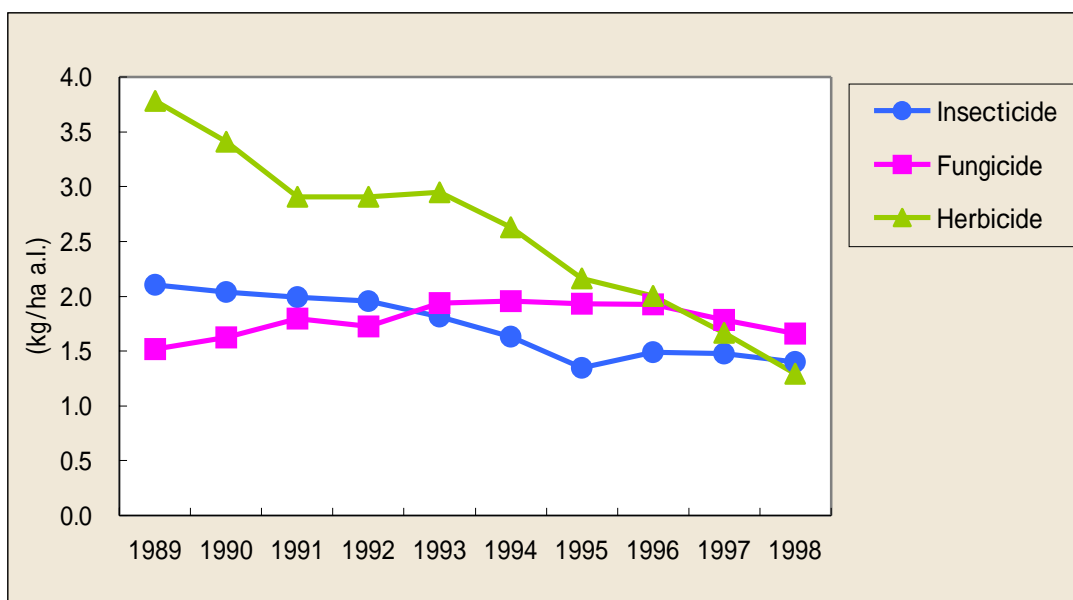


Figure 2. The trend of the risk to fish and Daphnia for 10 years on unscaled ADSCOR

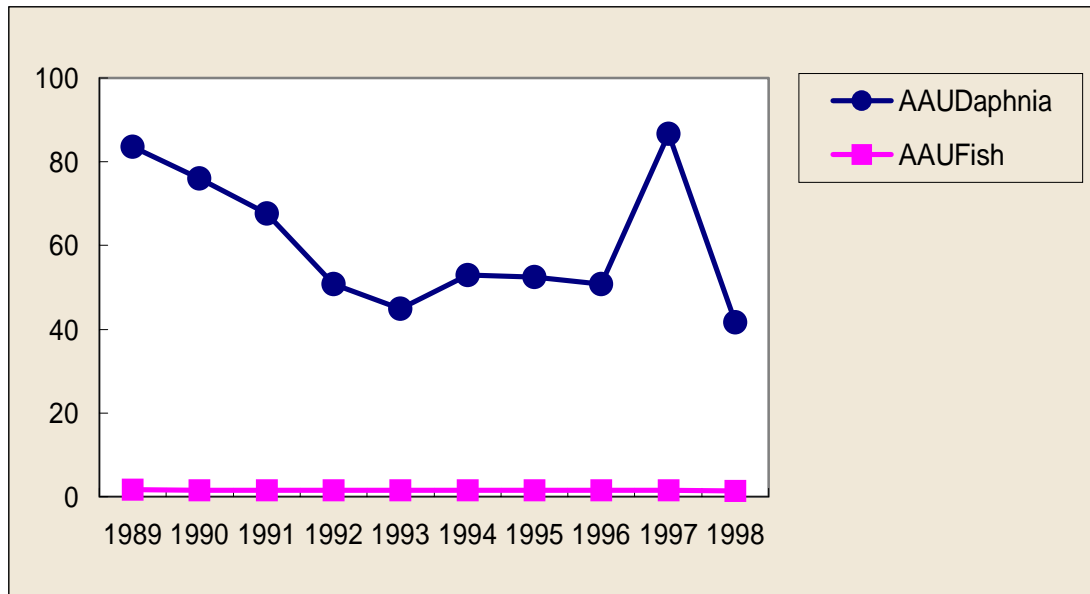
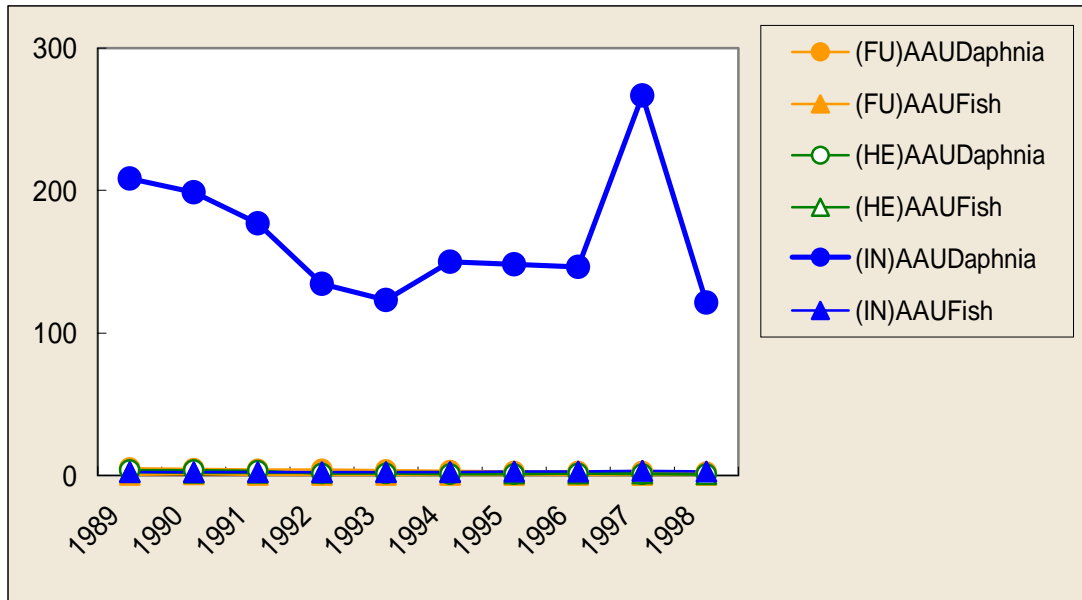


Figure 3. The trend of the risk to fish and Daphnia for 10 years on each pesticide group on unscaled ADSCOR



* FU(Fungicide), HE(Herbicide), IN(Insecticide)

Figure 4. The trend of the risk to fish and Daphnia for 10 years on each pesticide group except insecticide on unscaled ADSCOR

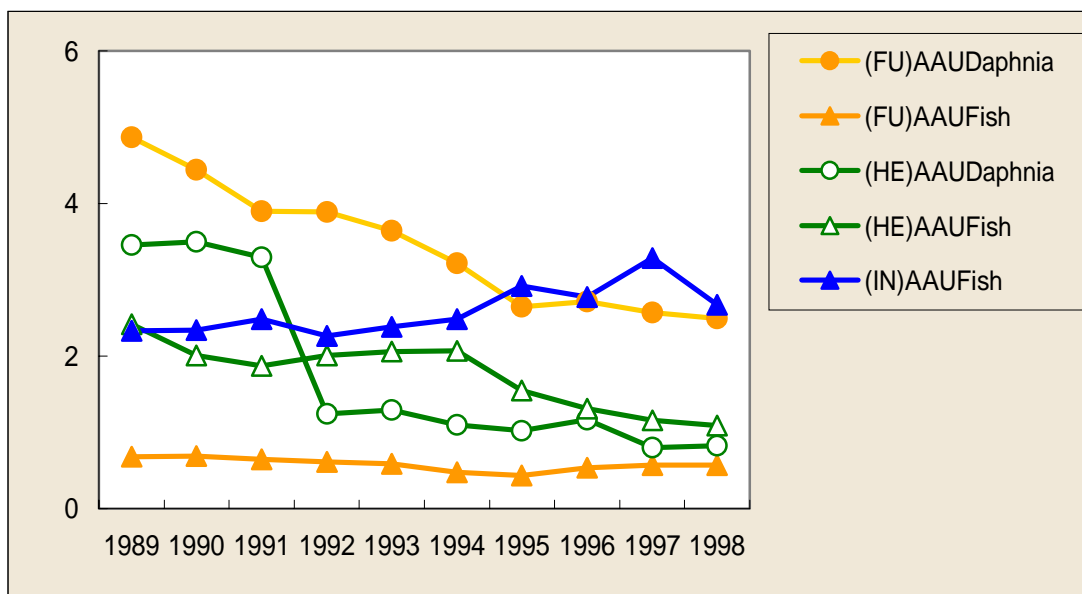


Figure 5. The trend of the risk to Daphnia for 10 years on the top 3 of the average risk of each insecticide by unscaled ADSCOR

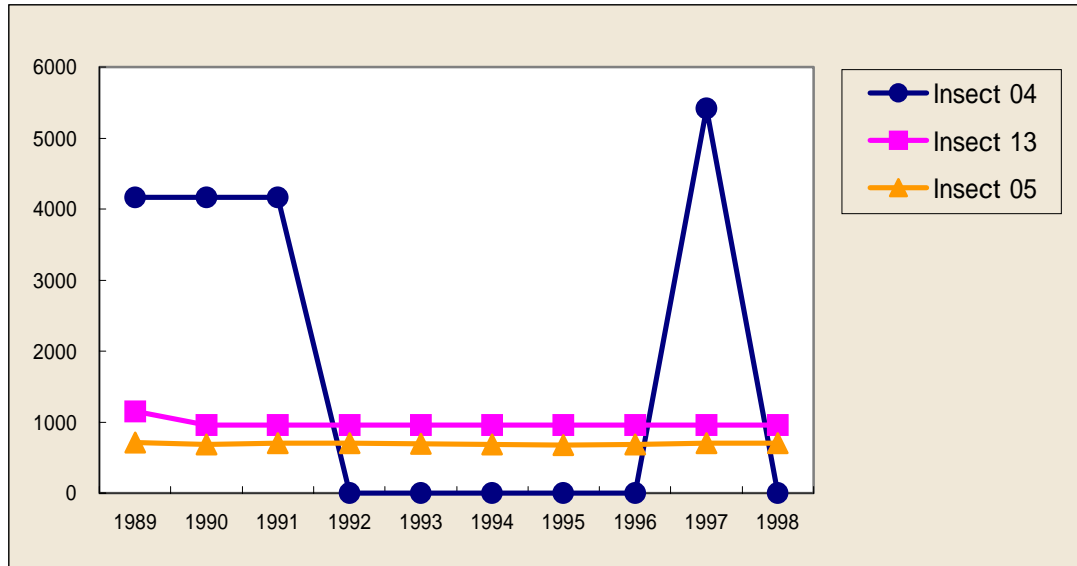


Figure 6. The trend of the risk to fish and Daphnia for 10 years on scaled ADSCOR

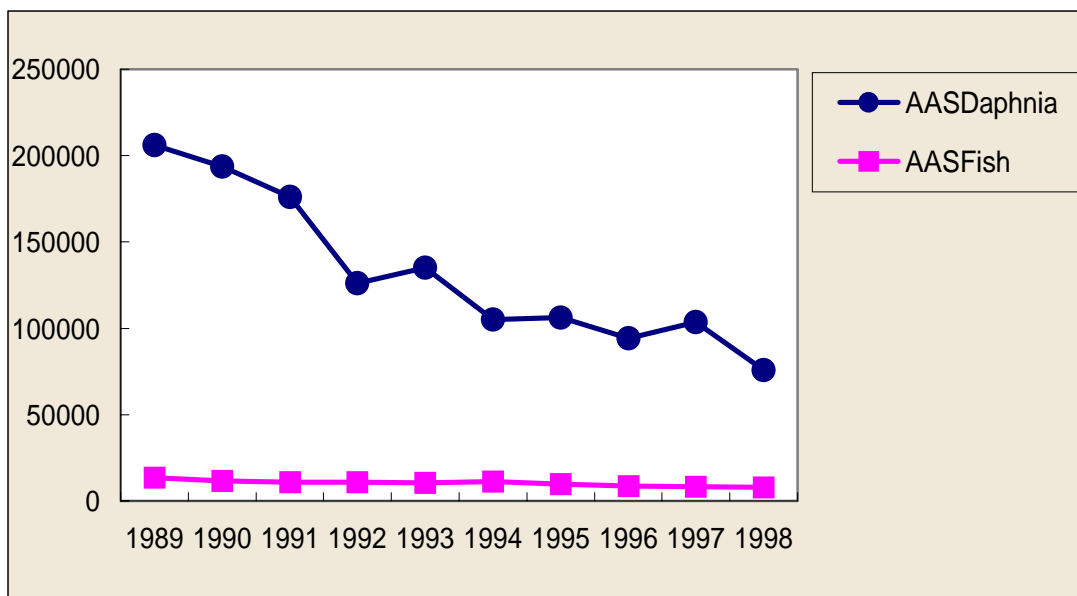
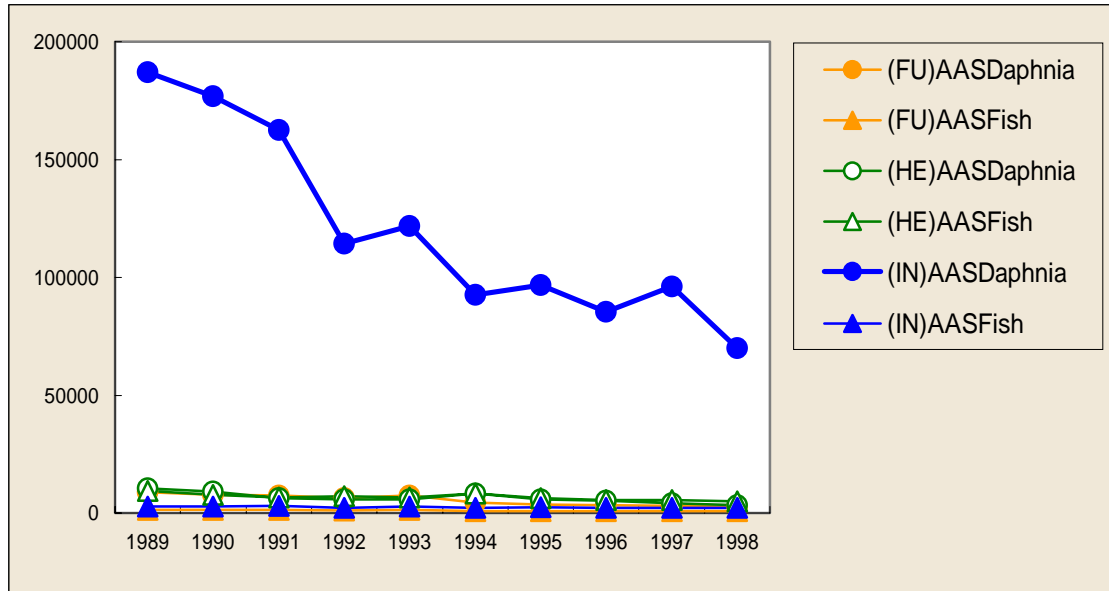


Figure 7. The trend of the risk to fish and Daphnia for 10 years on each pesticide group on scaled ADSCOR



* FU(Fungicide), HE(Herbicide), IN(Insecticide)

Figure 8. The trend of the risk to fish and Daphnia for 10 years on each pesticide group except insecticide on Scaled ADSCOR

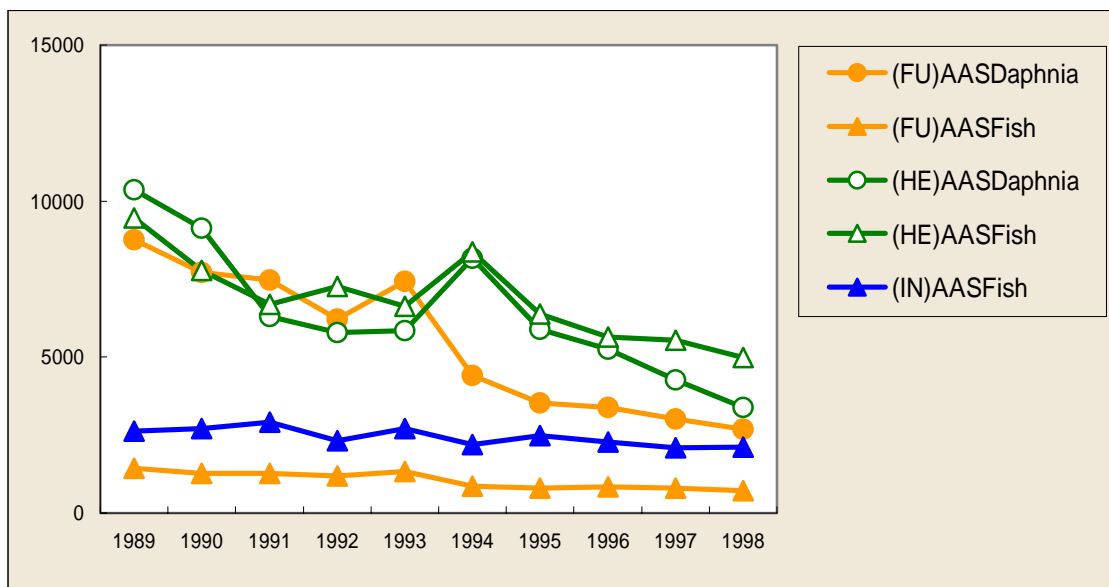


Figure 9. The trend of the risk to Daphnia for 10 years on the top 3 of the average risk of each insecticide by scaled ADSCOR

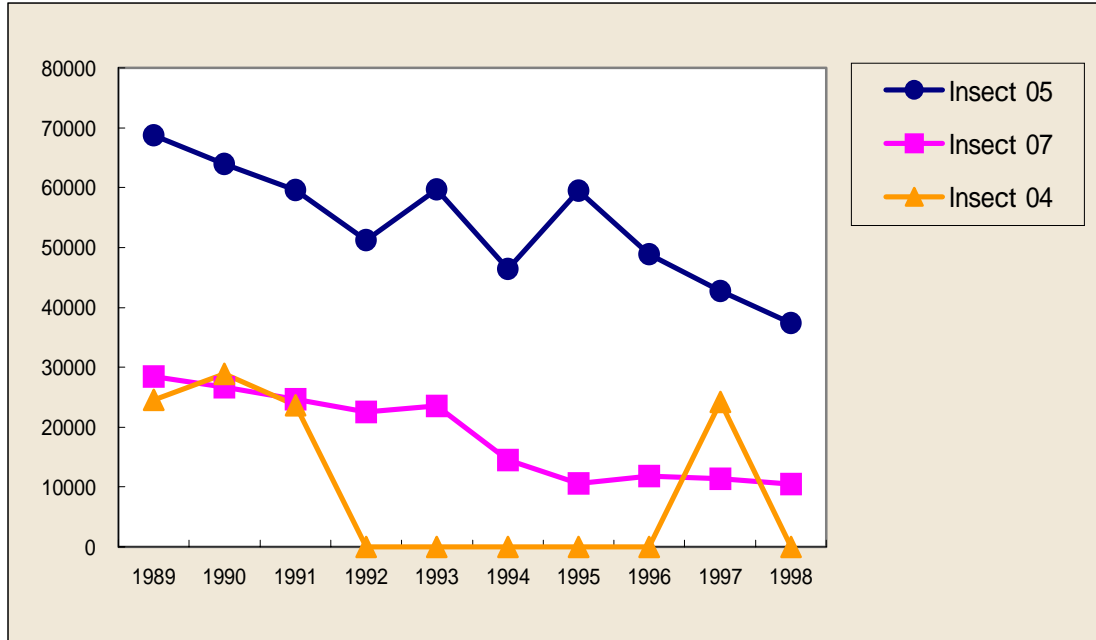


Table 2. The comparison between the top 3 of unscaled risk indicators to Daphnia by ADSCOR and the basic area treated (BAT) in 1997

Blind name	The value of Risk indicator
Insect 04	5417
Insect 13	962
Insect 05	700
Insect 10	688
Insect 11	636
Insect 19	185
Insect 03	138
Insect 09	120
Insect 12	91
Insect 07	74

Blind name	BAT
Insect 07	154.5
Insect 16	152.3
Insect 15	110.3
Insect 01	105.5
Insect 05	62.5
Insect 21	53.0
Insect 20	37.6
Insect 12	21.4
Insect 17	20.6
Insect 14	14.3
Insect 28	14.0
Insect 19	13.1
Insect 10	8.1
Insect 22	6.4
Insect 25	6.3
Insect 04	4.4
Insect 06	4.0
Insect 13	2.4
Insect 03	2.2
Insect 09	1.5
Insect 11	1.4

Figure 10. The trend of the risk to fish and Daphnia for 10 years on SYSCOR

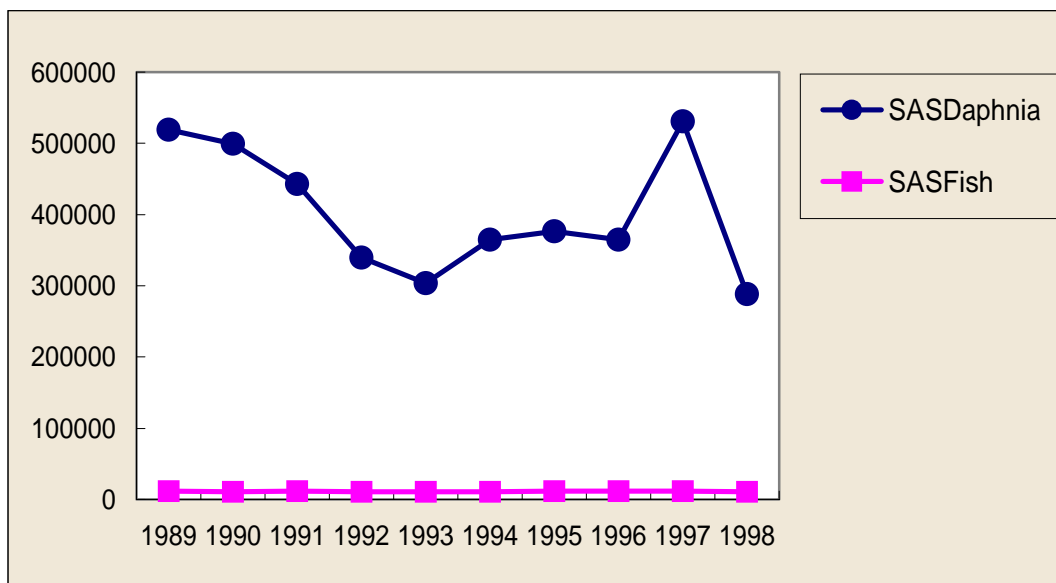
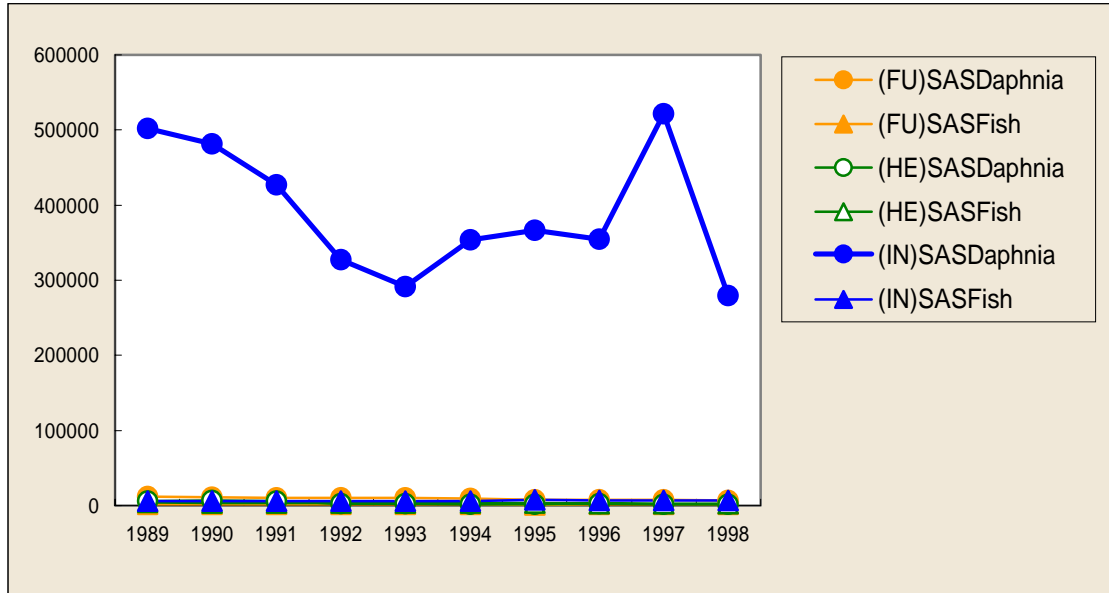


Figure 11. The trend of the risk to fish and Daphnia for 10 years on each pesticide group on SYSCOR



* FU(Fungicide), HE(Herbicide), IN(Insecticide)

Figure 12. The trend of the risk to fish and Daphnia for 10 years on each pesticide group except insecticide on SYSCOR

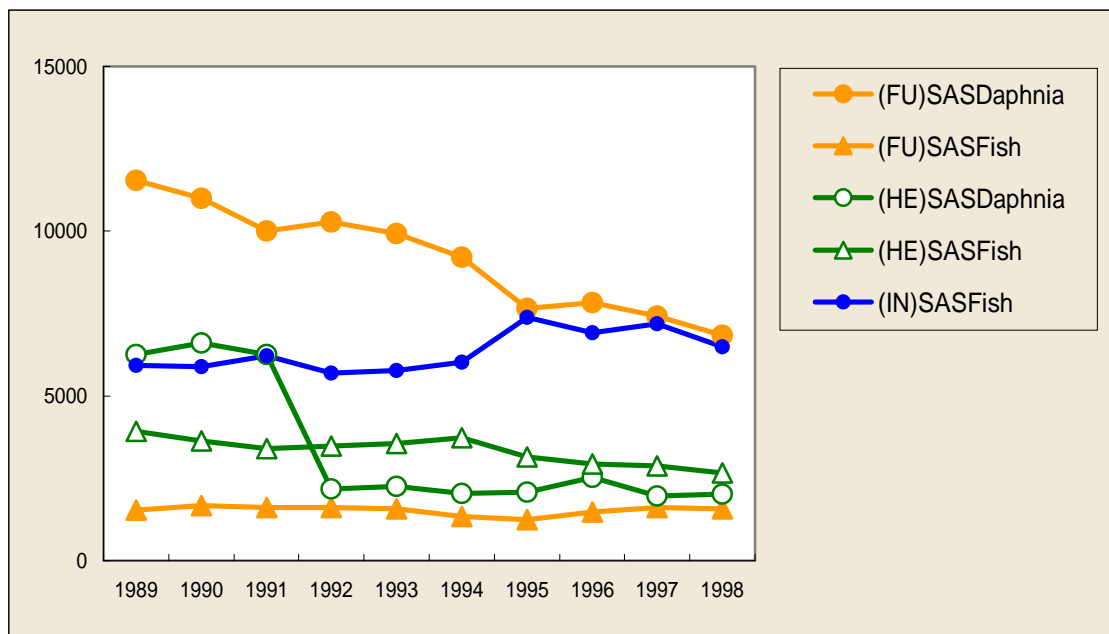


Figure 13. The trend of the risk to Daphnia for 10 years on the top 3 of the average risk of each insecticide by SYSCOR

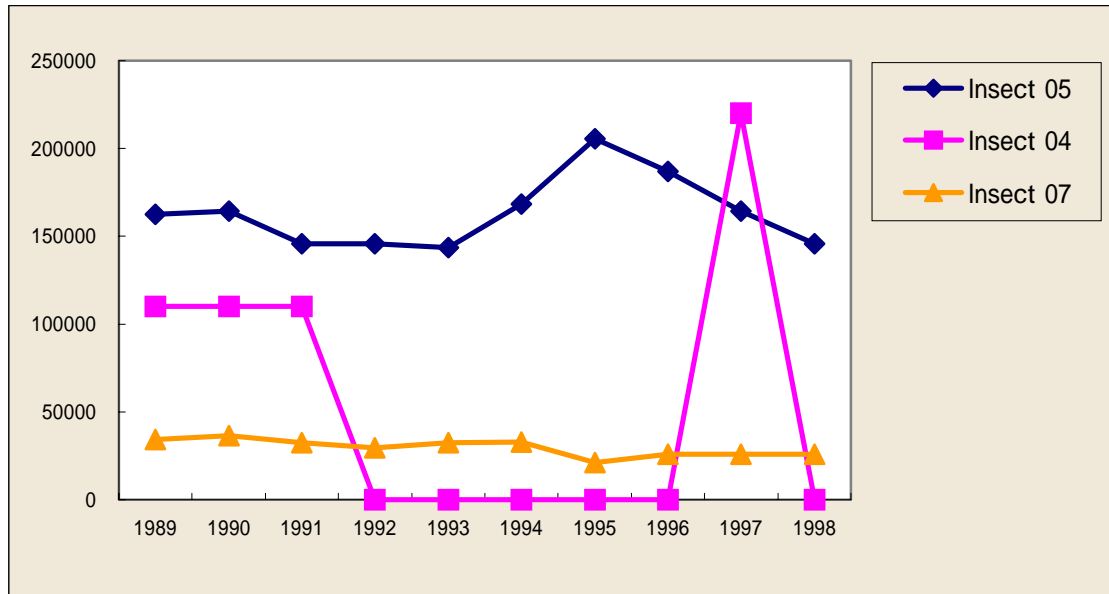
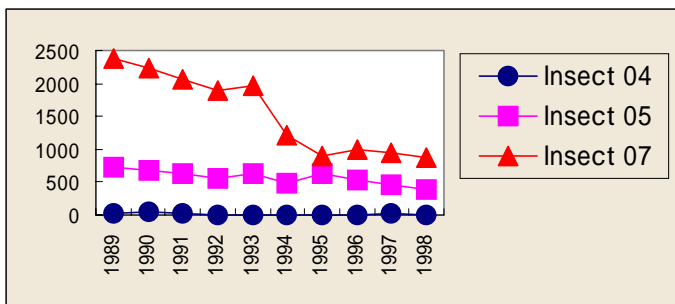
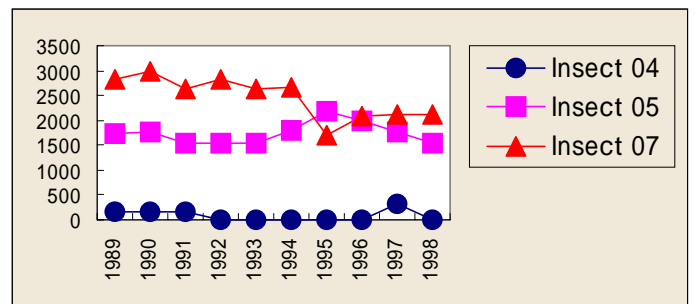


Figure 14. The comparison of the exposure and the risk trends from scaled ADSCOR and SYSCOR among Insect 04, Insect 05 and Insect 07

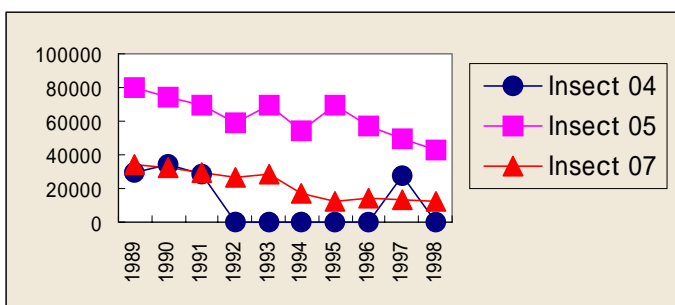
Exposure from scaled ADSCOR



Exposure from SYSCOR



Risk trend from scaled ADSCOR



Risk trend from SYSCOR

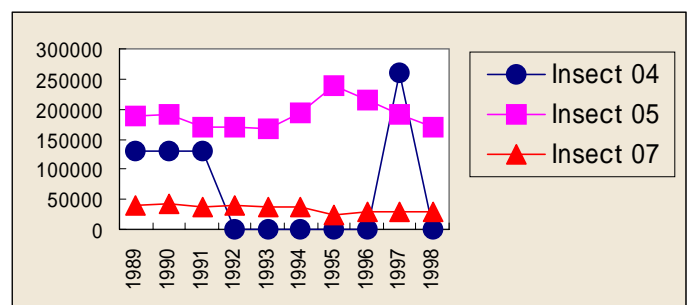


Figure 15. Sequence of scatter plots of hazard of Daphnia vs. exposure for 10 years on insecticide

