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WETLAND DEVELOPMENT, REFORESTATION, and PESTICIDE RESIDUE ASSESSMENT in SYSTEM B

Part II

by

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MARD PROJECT
PIMBURATTAWA

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A

TABLE OF CONTENTS

INTRODUCTION 1

WETLAND DEVELOPMENT 1

Menik Ela Wetlands 1

Block 503 Wetlands 2

Why Wetlands? 4

REFORESTATION 5

Kuda Oya Reforestation Project 5

Kuda Oya-Block 503 Reforestation 6

Menik Ela 7

Native vs. Exotic Species 7

PESTICIDE RESIDUES AND WETLANDS 8

Maha Analyses 8

Wetland Water Quality Sampling Plan 8

RATNAPURA WORKSHOP 11

RECOMMENDATIONS 11

REFERENCES 13

B

INTRODUCTION

During the summer of 1992, a wetland assessment of Zones 1 and 5 of System B (Davis, 1992) recommended that wetlands in Block 503 be protected and enhanced during infrastructure development, riparian forests along the Kuda Oya be restored in Block 502 and protected and enhanced during development of Block 503, a program be instituted to monitor water quality in drainage water, and consideration be given to retrofitting developed areas in Zone 1 and 5 with wetlands. During subsequent visits by this consultant a reforestation project for the Kuda Oya in Block 502 was designed and later initiated; a study of IPM, Pesticide Residues and Water Quality was designed and initiated with participation by Drs. Ajantha Perera, environmental toxicologist at the University of Colombo, and James Burleigh, MARD plant pathologist; and detailed plans were developed for the creation of a new wetland complex on the Menik Ela in Zone 1. Follow-up visits were made to Block 503, the Menik Ela and the Kuda Oya Reforestation site to monitor project operations and recommend alterations. For details, see Davis (1993, 1994).

As a result of these activities, four projects are underway to enhance biodiversity and improve environmental quality and health in System B.

- Wetlands and riparian forest reserves have been included in the design of irrigation infrastructure in Block 503.
- A new wetland complex has been constructed adjacent to the Menik Ela and reforestation of the area is planned.
- A riparian farmer organization is planting and maintaining native, Dry-Zone trees along the Kuda Oya in Block 502 and plans are in place to expand this effort downstream along Block 503 and to other areas in System B.
- One Maha season of sampling has been completed on pesticide use and pollution on farms adjacent to the Narana Ela wetland in Block 502, and wetland water, soil, and tissues samples have been analyzed for pesticide residues.

This report covers twelve days of in-country consultancy activities for MARD during June of 1994 including:

1. Participation in MARD workshop on Sustainable Development at Ratnapura including presenting of lectures on wetlands and conflict resolution, 3 days.

2. Visit to MARD to assess progress on above projects and make recommendations, 9 days.

WETLAND DEVELOPMENT

Menik Ela Wetland Complex

Earthworks have been completed on the drain linking the three wetland cells, and control structures have been installed on the two wetlands closest to the Menik Ela (see Fig. 2 in Davis, 1994). Level determinations showed the third depression to be higher than the bed of the Menik Ela at the point of outflow into the wetland complex. This depression collects runoff water which flows back toward the ela rather than toward the new drainage ditch. Therefore, the drainage ditch was contoured to ground level so that it can receive spillage from the depression during Maha, but no control structure was installed. Other ephemeral wet areas south of these three cells will be

drained. The inflow to the first wetland has been opened and it is full of water, but at current river levels there is no spillage. A rise in ela level of a couple of centimeters will cause spillage with the control structure full open. Inflow channels to the second wetland and the connection of the third depression to the inflow channel are being excavated as this report is being prepared, and all channels should be cleared by 25 June. An inspection will be made on the 26th.

For the most part, the banks of the two active wetland cells are vertical and approximately 80 cm above the open spill level. The depth of the pools is approximately 70 cm. The second wetland at mean Yala flows will have a shallow area at its southern end that will range from 0-30 cm in depth, but similar areas in cell one are limit. These shallow areas are currently under grass cover which will probably be killed by standing water and replaced by hydrophytic plants. Similarly, inflow channels and the drain will become colonized by hydrophytes once they become saturated. This process of natural colonization will take from two to five years to equilibrate.

I am not recommending any plantings of wetland plants at this site. The objectives of establishing this wetland complex were to see what could be accomplished with minimal effort and expense for construction and minimal maintenance. We will allow this wetland complex to "self design" through invasion and spread of wetland plants and animals. Once this occurs, the wetlands will require no maintenance unless inlet channels become blocked during Maha flooding. In the short term, however, the Block Manager should inspect the site frequently to insure that inlet and drainage channels have not become blocked by human activities.

Trees - As noted below and in previous reports, I recommend that the area southeast of the MARD Road, north and east of the Menik Ela and south of the Mahaulpota-Menik Ela Road and the dike between sites A and B be reforested, e.g. sites A and D in Figure 1 on Davis, 1994. This should be done with native Dry Zone species.

Block 503 Wetland Development

Four major wetland sites were identified in Davis (1992) to be retained and enhanced in infrastructure design for Block 503. Further inspections over the past eighteen months have revealed other options. Therefore, six actions are recommended: (1) construction of the planned wetland at the mouth of the Wali Ela as described below; (2) construction of a tiered chain of wetlands on the Narana Ela where the larger wetland complex was identified in my 1992 report - Central Narana Ela Wetland Complex; (3) abandonment of any overt wetland construction at the smaller Narana Ela site farther south; (4) the incorporation of existing low areas into drainage channels with minimal excavation; (5) establishment of control structures on all natural outflow channels draining into the Kuda Oya to allow for wetland establishment, and (6) the establishment of a wetland at the point where the Narana Ela empties into the Kuda Oya.

1. *Wali Ela Confluence with Kuda Oya:* Site visits to Block 503 over the past year have revealed that the Wali Ela is a narrow stream with high banks for most of its length, especially at it northern end. Construction of shallow areas will be expensive and need not be considered. I recommend that the Wali Ela wetland be constructed at the confluence by constructing a concrete dike to separate the Wali Ela from the Kuda Oya main channel, diverting the Wali Ela into a right-bank side channel of the Kuda Oya which is now dry except during Maha floods. A concrete dam with a control structure will have to be installed where the side channel empties into the Kuda Oya and bed grading will be needed to remove accumulated sand (Figure 1). Reeds should be planted in the wetland bed. Some wetland development will occur naturally upstream on the Wali Ela. Trees along the Wali Ela should be retained and enhanced by plantings.

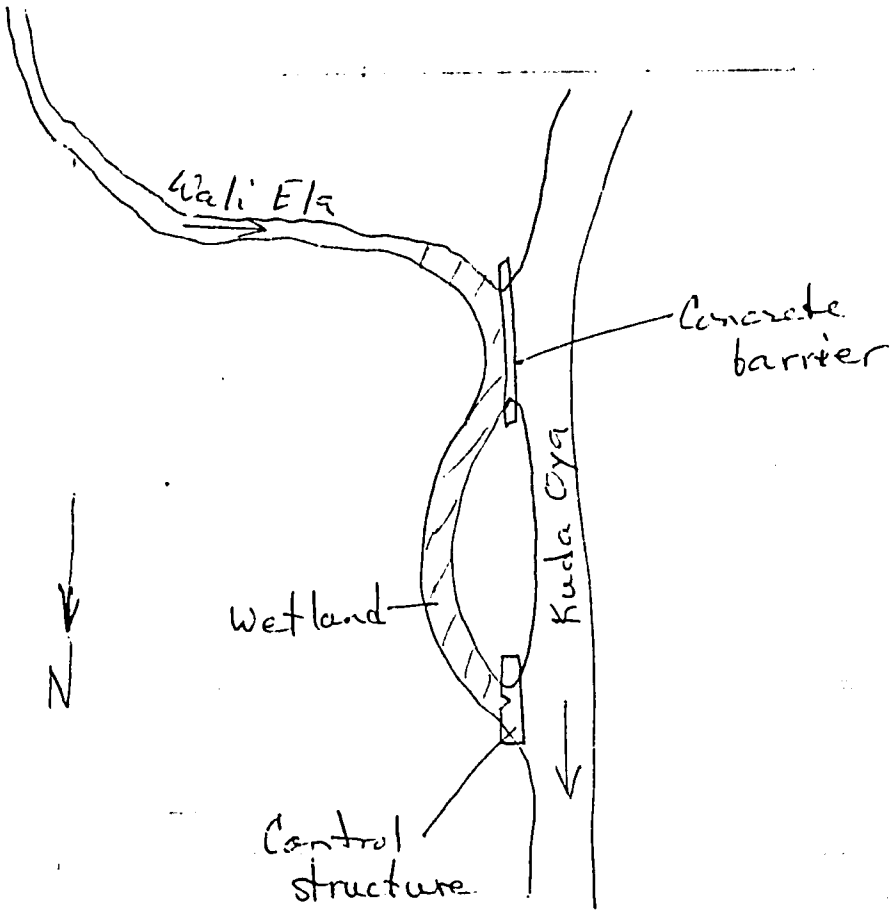

Figure 1. Wali Ela wetland design.

2. *Central Narana Ela Wetland Complex:* The improved Narana Ela gradient at this point is close enough to the land surface to allow for some creation of shallow areas as mandated in the ecological design criteria in my 1992 report. The drop from this point to the confluence with the Kuda Oya is also steep enough to allow for the installation of a chain of three or four wetland cells of proper design. This will require some grading, but this should be done. The wetlands should be considered part of the infrastructure and constructed to design criteria in Davis, 1992. These cells will have to be planted with appropriate hydrophytic plants. Control structures should be designed to insure that retained water does not back up into cultivated land.

3. *Small Central Narana Ela Wetland:* A visit to the site of this proposed wetland this month revealed that the bed of the improved Narana Ela at this point lies at the bottom of a channel that is at least two and sometimes three meters deep. The sides of the channel are nearly vertical and the water flow is expected to be at least one meter deep even during Yala. There is no reasonable opportunity for excavating a shallow wetland at this point. Some wetland plants

will occupy the water edges naturally over time, but no effort should be made to create a functional wetland at this site.

4. *Incorporation of Existing Low Areas into Drain Design:* During three visits to Block 503 during this visit, Mr. Satgunasingham pointed out several natural low areas that will be incorporated into the drainage scheme and maintained in natural state much as has been done on the Narana Ela wetland in Block 502. As noted in earlier reports, I strongly encourage this action and hope that it will be carried out with diligence.

5. *Major Natural Outflow Channels to the Kuda Oya:* On an inspection tour of the right bank of the Kuda Oya, Mr. Satgunasingham identified several broad outlflow channels emptying into the Kuda Oya and indicated that these could be converted into wetlands by constructing small dams at their mouths and including control structures. This would be an excellent plan. These areas are moderately broad and will undoubtedly develop wetland characteristics with or without our help. But, wetlands at these sites could be enhanced by minor water control at the outlet. As Mr. Satgunasingham pointed out, farmers will dam these channels even if MARD/MEA doesn't, so they can water buffalo and grow fish. Control structures will enable managers to drain the wetland areas periodically. Control structures should be not more that one meter high.

6. *Narana Ela-Kuda Oya Confluence:* No visit could be made to the confluence of the Narana Ela and Kuda Oya, so no recommendation is possible regarding details of wetland development at that site. Suffice it to say that this is a critical site, and wetland construction should occur if at all possible.

Why Wetlands?

Questions are still being raised about why wetlands should be included in development projects in System B and elsewhere in Sri Lanka. This question is addressed in earlier reports, especially in Davis, 1992, but I again note the following points:

1. There are demonstrated benefits to maintaining landscape ecological integrity in development schemes. Natural ecosystems are extremely complex systems that contribute in important ways to human beings and their social systems. For example:

   - Forests and wet areas have a marked impact on local and regional climates, even affecting precipitation patterns and amounts. The ameliorating effect of trees and waterways are valued by people, especially in areas where other human amenities are scarce or too expensive for the populace. One need only look at areas where humans have had the ability to mold their local habitats to their liking to find that they plant trees and capture water.

   - Wetlands provide areas for bathing, fishing, fish rearing, buffalo and cattle watering, and other amenities important to humans, especially human with marginal economic flexibility.

   - Wetlands have been shown to purify waters passing through them, and preliminary results indicate that System B wetlands may be doing this too. Pesticides appear to be accumulating and degrading in the soils and vegetation of wetlands. More data are needed to verify this and reveal how other pollutants are being impacted.

- Wetlands and forests are complex communities of plants and animals. Some of these animals are important to adjacent human populations. For instance, there is some evidence that insects and arachnids that inhabit natural forests and wetlands may be important predators on economically important pests.

Other benefits of maintaining ecologically diverse landscapes could fill tens of pages of this report; whole books have been written on the subject. I will note only tw additional reasons for maintaining and installing wetlands and forests in System B and elsewhere.

- *It's Required:* Maintaining and enhancing biodiversity is required on all projects supported by USAID and this is a growing tendency among donor agencies, especially after the Rio Conference. Wetland and forest development and conservation enhance the natural biodiversity of Sri Lanka and contribute to long-term ecological stability of the area and region.

- *Costs are Marginal at Worst:* Maintaining wetlands and building them into project infrastructure adds little to the cost of the project if done from the beginning of project design. Construction costs are marginally higher at worst and may be lower if natural areas are utilized without improvement. Further, costs are greatly reduced if conservation and enhancement is done at the time of project development rather than being retrofitted or repaired later with all the added costs of recontracting and compensating for environmental damage. The potential benefits from conservation and maintaining ecological stability are vast and the costs are marginal-so why not do it?

REFORESTATION

Inspection tours were made of the Kuda Oya Reforestation site in the presence of Mr. Mahinda Panapitiya (MARD) and riparian farmer environmental organization president Mr. Bandara and of the riparian forest on the right bank of the Kuda Oya in Block 503.

Kuda Oya Reforestation Project

Survival and vigor of trees planted at the beginning of Maha is generally good, although not consistently so. Farmers who have fenced and watered have good survival. Kumbuk is especially impressive, having grown more than a meter. Where farmers have not watered, trees are stunted and struggling to survive. Now that the paddy is ready, time may be available for tree watering, so those stunted trees may still survive. There is justifiable concern about the danger of fire in the planted areas. The dominant plant in these areas is illuk or Imperata Grass which grows very fast and is dry a tinder this time of the year. Any spark, from a cigarette, from a burning rice paddy, or from threshing areas can set the illuk ablaze. The young trees will not survive such a fire until they are four of five years old. Steps should be taken to guard against fire starting and spreading. It is doubtful that controlled burns would work in this situation. The trees are too vulnerable and the ground fire would be hard to control without water sprayers. Fire breaks should be constructed across the dikes to stop the spread of grass fires. Fire breaks should also be constructed at the foot of the dikes adjacent to field that are to be burned. MEA will have to be prepared to replant burned areas during these initial years of establishment.

Total number of planting plots, e.g. riparian farmers participating in the project		**56**
Plots damaged by fire to date in which 50% of trees were destroyed		**10**
In these plots, Kumbuk and bamboo were not damaged, because fires originated on the paddy side of the dikes.		
Casualty Rates	**20%** death of tree seedlings per plot	**16**
	30% death of tree seedlings per plot	**30**
Plots fenced by farmers		**15**
Total survival (of 20,000 seedlings planted)		**15,000**
Almost all Kumbuk and bamboo have survived		
Six farmers from the Kuda Oya Riparian Environmental Organization have been trained in nursery production techniques for bamboo.		

Table 1. Status of Kuda Oya Reforestation Project plantings as of 14 June 1994. (Source, MARD report, 14 June 1994)

Kuda Oya, Block 503 Reforestation

Improvement of the Kuda Oya channel adjacent to Block 503 has disrupted extensive stretches of the riparian forest, but has left other stretches largely untouched. Reforestation and forest enhancement should proceed immediately according to recommendations in previous reports (Davis, 1992, 1993, 1994). Similarly, reforestation should proceed rapidly on the banks of the Narana Ela and on forest reserve areas above command. It is essential that natural forest width specifications set forth in Davis, 1992 be observed and that these areas be planted to native Dry-Zone species only.

After an assessment visit to the right bank of the Kuda Oya, it was determined that much of that bank is high above the Kuda Oya and should be suitable for homestead development. MEA and MARD should carry out an assessment of this area to determine if it is suitable for settlement. If it is, consideration should be given to establishing an access road along the right bank outside the reserve area and assigning homesteads along the river-side of this road to farmers who agree to guard and maintain the forest preserve area adjacent to their homesteads. Compensation for this would be that fruit and medicinal trees may be planted on the outer edge of the reserve area as is being done upstream in Block 502. Farmers would construct their houses and other homestead facilities outside the reserve area, and the road would separate these homes from the adjacent irrigated fields. Farmers who are not interested in protecting the reserve forest should not be assigned homesteads in this area, and those who fail to protect the forest area under their charge should be relocated to an ecologically less sensitive homestead area. There will be trade offs resulting from this scheme. Homesteads would reduce the width of the reserve zone in places. But, if a minimum of twenty meters of native forest is maintained and this is augmented by plantings of fruit and medicinal trees on the homestead edge of the reserve area, the trade offs should be largely positive. The interest that the farmers will take in protecting the native forest will probably more than offset the narrowing of the native forest band - and shade will still be afforded

by the fruit and medicinal trees, adding to the natural forest habitat.

A similar strategy might be employed on appropriate high ground along the Narana Ela and in the above-command area in the southern end of Block 503 designated for forest reserve planting. The long-term sustainability of reserve forests will be enhanced if local farmers assume interest in them and responsibility for them. Enlightened self interest is far more effective in insuring such protection than are any appeals to altruism and are less expensive than extended payment-oriented schemes.

Menik Ela

Bank stabilization plantings are planned for the Menik Ela left bank and should proceed as fast as possible. As noted above, immediate reforestation should be carried out at Sites A and D on the right bank (see Figure 1, Davis, 1994).

Native vs. Exotic Species

There is an ongoing debate concerning the best trees to plant in a reforestation programme; one side wanting to plant native species, the other extolling the hardiness and ease of establishment of exotics. I want to come down strongly on the side of native species, for the following reasons.

1. The goal of the reforestation projects in System B are not simply to plant TREES. Trees alone do not a forest make. The objective of the MARD reforestation effort is entirely directed toward increasing and enhancing the native biodiversity of System B by conserving and/or reestablishing native, Dry-Zone forests. Biodiversity conservation and enhancement is not only and ecologically sound strategy for Sri Lanka; it is mandated by USAID and therefore must be part of the MARD effort.

2. What is a forest? A natural forest is a complex community of plants and animals that evolve over time to form a stable ecological system that is adapted to local climatic conditions and capable of adjusting to changing ecological/climatic conditions. In other words, a forest is a PROCESS. Native, Dry-Zone trees have evolved in this region and are adapted to the ebb and flow ecological conditions in eastern Sri Lanka. When we plant native trees and nurture them we are initiating a process of vegetation and ecological community development that will become self directing and self maintaining as it matures. Exotics such as *Casurina, Eucalyptus,* and *Acacia* are, indeed, hardy plants that survive and thrive when planted in eastern Sri Lanka, just as they do elsewhere in the world where they have been introduced. That's why we like them so much as a source of biomass. These plants have evolved in habitats that demand aggressive, exclusionary ecological strategies for survival. These exotics survive and grow, but they do not create conditions favorable for the establishment of other plant and animal species; indeed they are so aggressive that they actively exclude other species. The result is a woodland of one or a few species - not a forest in the ecological sense of a complex community. We want native forests, not wood lots of exotics. (See #4 below)

3. Native forest communities enhance the local environment, including soils, water quality, local climate and human habitat. The most popular exotics tend to destroy ecological integrity over time, depleting soil moisture, toxifying the soil, killing soil organisms. For instance, pine plantations in the central highlands are devoid of earthworms. Note above the comments on the value of wetlands as communities that provide services for human populations by virtue of their complexity and stability. The same can be said of native forests.

Having noted these ecological concerns, I must note that exotic species have been used successfully in schemes to grow climax native tree species. As noted in my 1992 report, many climax tropical forest species are adapted to growing in dense shade and their seedling do not grow well in full sunlight. One strategy for establishing native forests involves the planting a exotics to create a temporary canopy under which seedlings of the native climax species are planted. Once the native trees have become established, the exotics are removed. This scheme involves the temporary use of exotics and their removal before they cause serious damage to the soil.

4. The best use of exotics is in fuelwood production on managed plantations and woodlots. The establishment of fuelwood sources comprising exotics would contribute to the conservation of native forest communities by relieving them from the pressures from fuelwood collectors. Indeed, unless something is done to assure an economical, reliable, and accessible supply of fuelwood, efforts to conserve and/or reestablish native forests will ultimately fail, maybe sooner than later.

PESTICIDE RESIDUES AND WETLANDS

To address the complex issue of pesticide use, its runoff into effluent streams and the potential of wetlands as sinks for removing it from the water, an integrated IPM, pesticide use and wetland water quality study was recommended in August of 1993 (Davis, 1993). This study was implemented in part during the following Maha. The study focuses on controlled trials at the RARC and field assessments in cooperation with several farmers with fields adjacent to the Narana Ela wetland in Block 502. The primary intent of this study is to attempt to document what is being applied to crops, what happens to it in the field soil, where it goes once it enters the wetland, and how effective is the wetland in removing it from effluent waters. The Maha analyses have been completed and Yala analyses will begin this month.

Maha Analyses

Details of RARC and farmer field analyses are beyond the scope of this report. These data will be compiled by Dr. James Burleigh for the IPM and pesticide use aspect and by Dr. Ajantha Perera for the fate of pesticide residues in the fields. Data for wetland analyses are provided in Figure 2 on page 10. These preliminary data suggest that propanil, the test herbicide, is being taken up be hydrophytes. Tissue concentrations in these wetland plants remain high for sixty to ninety days after propanil spraying. It must be emphasized that these are very preliminary data and cannot be interpreted with confidence. They do suggest that the wetland ecosystem is active in some way, however, in compartmentalizing these chemicals. The ultimate fate of the propanil is unknown. It is probably degraded to secondary products, but it may also be released into solution in the wetland water and washed downstream. The latter possibility is unlikely though. Very preliminary analyses of water samples did not detect propanil in the water leaving the wetland.

Wetland and Water Quality Assessment

Beginning with the 1994 Yala season, a focused sampling scheme must be implemented to assess the role of the wetland in removing propanil from return flow waters passing through it and to identify where propanil goes in the wetland and what happens to it, e.g. is it broken down to harmless products or simply accumulated and what are the overall public health implications. A detailed assessment plan and proposal, including a budget, is being prepared separately by Drs. Perera, Burleigh and me. This will be submitted to Mr. Spake by July 1. This sampling scheme

will include the following features:

1. To simplify the assessment, propanil, an herbicide commonly used on rice in System B and elsewhere in Sri Lanka, will be used to assess the role of this wetland in removing agrichemicals from return flows. While each herbicide, fungicide and insecticide will have its own characteristic interaction with the wetland, we cannot study them all in this project. By focusing on propanil we will address the fate of this very commonly used herbicide and will get a general picture of the effectiveness of tropical, freshwater wetlands in removing such chemicals from return flows passing through them.

2. Water samples will be collected at the points where return flows from the test fields enter the wetland. These samples must be taken immediately after chemicals are applied to the fields and have had a chance to be flushed off by rainfall or irrigation flows. This will require close coordination with the cooperating farmers; someone from MARD will have to be prepared to sample on short notice. Samples should be collected every 12 hours for two or more days after the water event to insure that pesticide-laden water is not missed as it passes into the wetland. Drs. Perera and Burleigh will have to use their judgement at the time to estimate the required sampling duration.

   Because many farmers have already sprayed their Yala herbicides, it may be necessary to simulate the runoff event as an initial step in the assessment. To do this, a predetermined quantity of propanil may be added to return flows at the point that they enter the wetland. This would be done over a period of hours to simulate the gradual movement of chemicals in runoff flows. The fate of this injection of propanil would then be monitored in the wetland downstream of the injection point. Subsequent assessments will be tied directly to actual application times as noted in the previous paragraph. These assessments will be carried out through the end of Maha season in 1995 to provide data for a full year.

2. Water samples must be taken in the channel of the wetland upstream from the field input point to assess propanil content of waters already in the wetland. This should be done at least three to six meters upstream of the input point to insure that input propanil does not infect this sampling point.

3. Water samples should be collected at the bridge (wetland outfall) at daily intervals for one week after the input event and weekly after that for ninety days. If pesticides are not detected in this water, sampling intervals can be increased to every two weeks.

These three samplings, if timed well to coordinate with field applications, should give a rough black box picture of what is happening to propanil in the wetland. Residence (turnover) time must be determined for the stretch of the wetland between the inflow point from the field and the outflow at the bridge, e.g. how long does it take water entering the wetland at the inflow point to leave the wetland at the bridge? MARD should have one of its engineers calculate mean residency time of water in this stretch during Yala and residency Meha residency times excluding flood events.

The fact that our preliminary data show that propanil is being taken up by wetland plants is significant and is important for two reasons: (1) it demonstrates that the wetland plants are removing pesticides from the water, or more probably from the soil; and (2) it raises concerns of public health, because some of these plants (especially kangkun and diya gowa) are regularly eaten by local farmer families and even taken as far as Polonnarua for market. For these two reasons, we need more information on where in the plants the propanil (and we can assume other

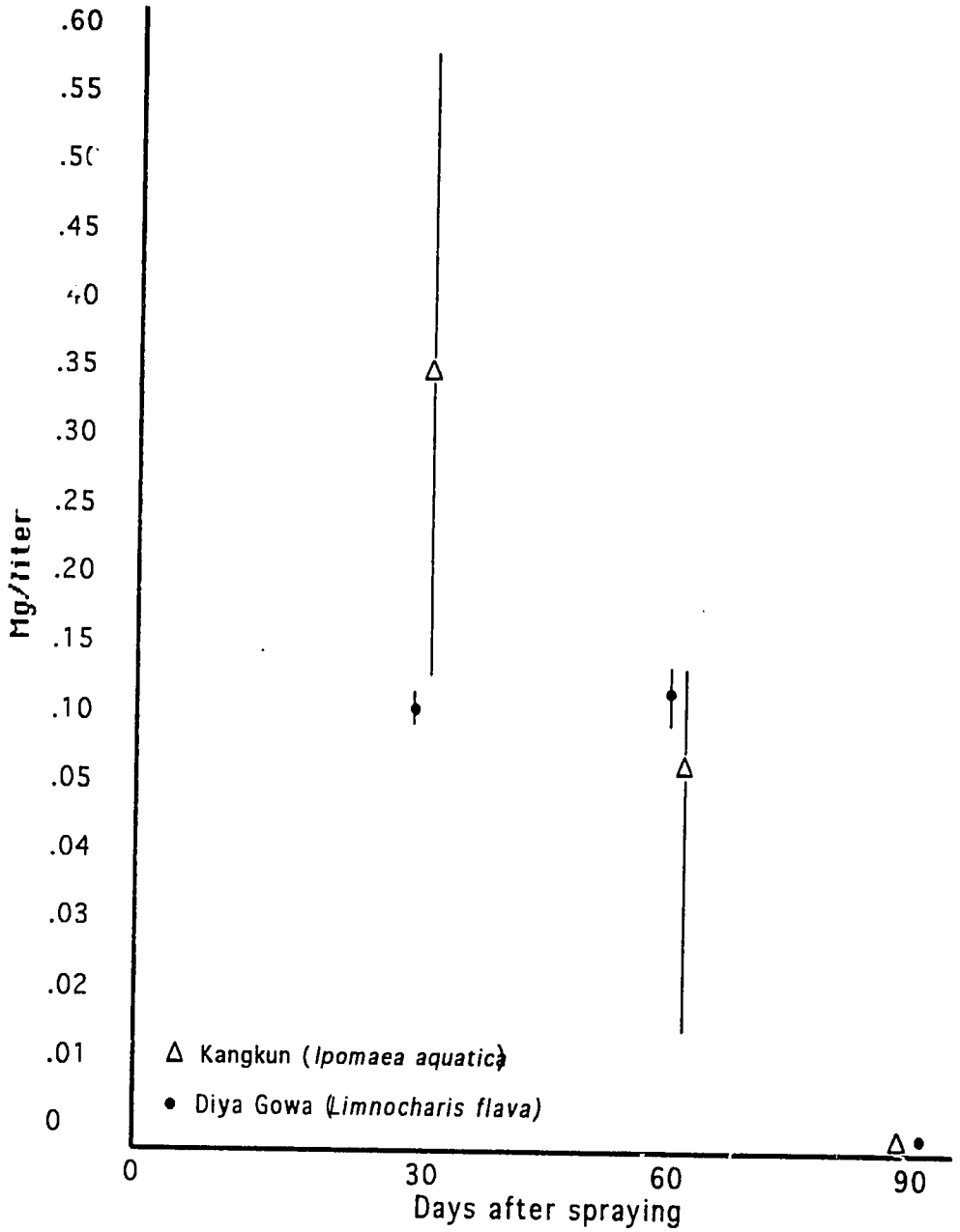

Figure 2. Propanil content of the tissues of two hydrophytes in the Narana Ela wetland over a ninety-day period after spraying in fields adjacent to the wetland.

agrichemicals) is accumulating and what is its fate in these tissues, e.g. is it being degraded in the tissues or is it released to the environment after the tissues die? To identify the fate of propanil in the wetland, a compartmentalization assessment will be done at the same time that the water samples are being taken.

1. At two-week intervals throughout each 90-day assessment, the following compartments of the wetland should be sampled:

   a. the top 2 cm of soil on the bottom of the wetland will be collected within patches of three dominant hydrophytes (*Ipomoea, Limnocharis, and Typha*) and in open water areas.

   b. rhizomes, leaf blades, and,in the case of kangkun, stems.

   c. grab samples of the dominant submersed and floating macrophyte species.

2. All samples will be analyzed for propanil and, if possible, its breakdown products.

3. A thorough vegetation analysis will be carried out to identify the macrophyte species and quantify biomass by species. This information will enable us to make rough estimates of the total capacity of the wetland to carry out any propanil removal identified in our sampling. It must be recognized that more than 150 fields drain into this wetland as does a small tank and an forest reserve area. We need to be able to extrapolate from the data gathered from the sampled area of the wetland.

RATNAPURA WORKSHOP

Comments received from participants following my presentations, especially following the presentation on wetlands, were very positive. MASL officials from Colombo were especially vocal in noting that they now understand the importance of protecting wetlands. My impressions of the overall success of the workshop are that it was very successful and should be repeated and workshops on other topics should be organized. Such activities serve as venues for the sharing of information, and they also provide valuable team-building experiences for System B and Mahaweli professionals.

RECOMMENDATIONS

1. Wetland Water Quality Assessment

   The wetland/pesticide study being carried out in Block 502 should be expanded and refocused to assess the role of the Narana Ela wetland in removing propanil from return flows passing through the wetland. Tests should be started immediately and monitored through Yala and the next Maha. The study design proposed in this report should be followed. Details will be provided in a proposal being developed separately by Drs. Perera, Bureigh, and Davis.

2. Menik Ela Site

   a. The inflows and outflows of the new wetland cells must be maintained until they stabilize. This will require regular inspection visits by Block officials and repair of any slumping or points of sedimentation.

b. No planting of wetland species should be done. Allow nature to take its course.

c. Reforest sites A and D.

3. Block 503

a. Establish new wetlands at the following points:

- the confluence of the Wail Ela and Kuda Oya,
- a series of small wetland cells at the site of the large "wetland area" on the Narana Ela in the center of the Block (see Davis, 1992),
- on all suitable outfalls to the Kuda Oya, and
- at the confluence of the Narana Ela and Kuda Oya.

b. Incorporate existing low-lying areas into drain schemes, allowing drains to assume natural contours as occurred at the Narana Ela wetland in Block 502.

c. No wetland development need be attempted at the smaller "wetland area" on the Narana Ela in the center of the Block, e.g. the one south of the large "wetland area" as defined in Davis, 1992. Topography and hydrology are inappropriate at this site.

d. Reforestation to establish native Dry-Zone riparian forests should begin immediately along the Kuda Oya and in the southern end of the Block. Reforestation of the Narana Ela should begin as soon as grade improvements are completed (see Davis, 1992 for specifications).

e. MEA should investigate the potential for establishing homesteads on high ground along the right bank of the Kuda Oya to determine if they are high enough to provide protection from Maha flooding. If this is determined to be so, homesteads could be assigned to 503 farmers who agree to maintain reforested areas adjacent to their homesteads. MEA should also explore the potential for similar settlement adjacent to other forest reserve areas in the Block. I consider this to be a potentially significant scheme for sustainability of the riparian and other forest reserves in the Block that could serve as a model for development and settling of the right bank of the Maduru Oya and other areas in the Dry Zone.

4. Kuda Oya Reforestation Project

a. Careful thought should be given by MARD to the problem of fire to determine if any steps can be taken to minimize the risk. One thing that should be done is clearing around each tree for at least on meter. This will provide some protection from grass fire and even in the absence of fire will remove competition from grass roots for scarce water during Yala. Further, farmers should be alerted to be especially careful when burning threshing straw or paddy to make sure that the fires don't spread or that sparks don't set fire to the illuk in the reforested zones. Free seedlings destroyed by fire should be replaced.

b. Farmers should be encouraged forcefully to water their plantings and water them deeply. Shallow watering encourages shallow root development that will limit the ability of these trees to reach deep water sources during Yala. It is better to water less frequently, but to water deeply when you water.

5. Native vs. Exotic Species

The purpose of the MARD reforestation projects is to restore native, Dry-Zone biodiversity in System B. Therefore, the planting of exotic species should be scrupulously avoided in these projects. This is not to say that exotics cannot be planted in other projects such as windbreaks and fuelwood plots, although I would encourage that windbreaks ultimately be planted in native species.

6. Fuelwood Demand

It is absolutely essential and critical that fuelwood supplies be created in System B. MARD/MEA should immediately explore strategies for developing fuelwood supplies that are easily accessible to all residents of System B and reasonably priced. Consideration should be given to allotting parcels in Block 503 from the outset for fuelwood production. Farmer organizations might be given control of these sites and the operation of the fuelwood industry. Alternatively, such operations might be franchised on a concessionaire basis to settlers who would operated them instead of or in addition to growing paddy or alternative crops. The fuelwood operations will have to be subsidized initially to insure income during the period of tree growth. Unless the fuelwood problem is solved, all reforestation efforts in System B will ultimately fail. Supplies must be easily accessible to residents in all areas of System B and must be reasonably priced. Failing this, we will find the residents cutting the forests.

7. Education and Training

MARD and MEA should rapidly expand all efforts to teach adults and children about the importance of natural ecological systems such as forests and wetlands, how these systems contribute to their quality of life, and how they can conserve and protect them. This should be a multi-faceted approach including materials development for the schools, brochures and pamphlets for the adults, local lectures and tours for adults and children, technical training in conservation for both adults and children, and the inclusion of conservation materials and programs in all extension efforts. Videos of local origin and focus could be powerful educational tools. Education and training should be given high priority.

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