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Survey of Research Priorities in Water Erosion, Waterlogging and Flooding in South Western Australia

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Disclaimer

The contents of this report were based on the best available information at the time of publication. It is based in part on various assumptions and predictions. Conditions may change over time and conclusions should be interpreted in the light of the latest information available.

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Contents

1. Introduction

In May 1986 a survey was conducted of country-based advisers and technical officers involved in soil conservation work. The survey aimed to find out how important water erosion, waterlogging and flooding were considered to be in different parts of the agricultural area, and to help research officers identify research priorities. This report summarises the results of the survey and draws some conclusions.

There were some limitations to the survey, which need to be considered when interpreting the results. Water erosion, waterlogging and flooding are inter-related forms of soil degradation, which can be defined in different ways. As the survey was carried out through the mail, different interpretations were placed on some questions (a fault of the survey). Another limitation was the lack of a complete coverage of the agricultural area. A requirement for completing the survey was several years experience in a district. Several respondents provided details on a previous district for which they had more experience. Some respondents had difficulty answering a question on the importance of the problems in their district due to the diversity of their district. Appendix 1 contains a copy of the survey form.

2. Importance of Water Erosion, Waterlogging and Flooding in each District

Respondents in the survey were asked to rate the importance of water erosion, waterlogging and flooding in their district. The rating ranged from 1 (extremely important) to 7 (not important at all). The results are given in Table 2.1.

Table 2.1. Importance of water erosion, waterlogging and flooding in each district

		Rating			
District	**Number of respondents**	**Water erosion**	**Waterlogging**	**Dynamic flooding**	**Static flooding**
Albany	1	5	1	6	3
Bunbury	1	5	3	7	7
Busselton	1	4	1	3	2
Esperance	7	6	1.5	6.5	5.5
Jerramungup	1	2	3	3	4
Lake Grace	1	3	6	5	5
Merredin	2	1.5	2	1.5	4.5
Metropolitan	1	4	1	6	4
Moora	2	4	3	4.5	4
Narrogin	2	2	1.5	5	4
Northern	3	1.5	3	4	4.5
Three Springs	2	1	2	1	2
Average	2	3.3	2.3	4.4	4.1

NB: The lower the number, the more important the problem was perceived to be.

Overall, waterlogging was seen to be the most important problem, followed by water erosion and flooding. Waterlogging was seen as being a problem in almost all districts, even in the Merredin District if it is associated with salinity. Water erosion was seen as a major problem in some inland districts with summer storms (e.g. Merredin, Three Springs, Jerramungup) as well as districts in the higher rainfall zones during winter (e.g. Northam and Narrogin). Flooding was seen as being important in some inland (e.g. Merredin, Three Springs) and coastal (e.g. Busselton) districts.

3. Research Priorities

3.1 Analytical method

Provision was given for the highest priority to be assigned to more than one area. Three methods of analysing the results were used:

3.1.1 Unweighted first priority

This method considered the first priority only. Where a priority was divided between topics, the points were also divided (e.g. if two topics were nominated, they were each given 0.5 points). This method was considered to give an indication of the most urgent research needs across the agricultural areas.

3.1.2 Unweighted top three priorities

The top three priorities were allocated 5, 3 and 1 points in descending order of priority. Where priorities were shared, the nine available points were also shared so that lower priorities were not advantaged by the sharing of the top priority points (e.g. if two topics shared the top priority, they were each given four points while the second priority received one point. If three topics were given top priority they each shared three points). This method was considered to given an indication of general research needs across the agricultural area.

3.1.3 Weighted top three priorities

The points calculated by method (ii) above were weighted according to how severe the problem (e.g. water erosion) was considered to be in the district (Section 2). This method was considered to give an indication of general research needs in the" areas most affected by the problem.

3.2 Water erosion

The survey listed twelve possible topics for research in water erosion (Appendix 1). These topics were grouped into four areas of study: understanding rainfall and runoff, soil conservation structures, tillage/stubble effects and determining the amount and effect of soil loss.

The results of the three analytical methods are summarised in Table 3.1. The order of inclusion in the table is the average of all three methods.

Table 3.1. Research priorities in water erosion measured by three methods

	Priority		
Research topic	**Unweighted first**	**Unweighted top three**	**Weighted top three**
Cost effectiveness of banks	1	2	1
Soil erodibility	2	1	2
Stubble and pasture cover	4	3	4
Amount of soil loss	3	5	5
Tillage	6	4	3
Design of structures	7	6 (equal)	6
New structures	5	8	9
Rainfall	8	9	8
Runoff mechanisms	10	10	7
Soil loss-productivity	11	6 (equal)	10
Computer model	9	11	11
Recovery after erosion	12	12	12

All three methods gave similar top priorities but later priorities varied between the methods. For example, the effect of tillage on runoff and erosion did not get many top priority votes but was ranked third when the top three priorities were weighted for the importance of water erosion in the district. The research priorities are discussed below, along with comments made by respondents when justifying their choice. The status of present and future possible research projects is also outlined.

3.2.1 Estimating the cost-effectiveness of soil conservation structures using existing information

This topic was given top priority as some respondents thought structures needed to be financially rewarding before landholders adopted them. Data on production losses as a result of erosion on different soil types, was identified as an essential requirement for carrying out the estimate, this priority highlights the lack of information on the amount of soil loss and on soil loss - productivity relationships, two other research topics.

To an extent this research need has subsequently been met by the "BANKS" spreadsheet model (Salerian and McFarlane 1987a). Three workshops have introduced 26 advisers and technical officers to the use of the model. The model has identified factors, which most affect the cost-effectiveness of structures and therefore should affect design criteria. Feedback on the usefulness of BANKS is needed to determine what changes are required to better meet the needs of country-based staff. At this stage, BANKS cannot be used to test the cost effectiveness of using structures versus adopting minimum tillage techniques to mitigate water erosion.

3.2.2 Determining the susceptibility of different soils to detachment and erosion

As erosion requires both detachment and runoff, it was clear from respondents' comments that the research topic "understanding runoff mechanisms" was included in this research need. Soils were seen as being very variable in spatial distribution as well as in susceptibility to erosion. Therefore constructing banks over large areas often results in low risk areas being treated unnecessarily. A knowledge of soil susceptibility is also required when making clearing control assessments.

An NSCP research project on soil factors affecting runoff and erosion has been proposed for 1988 to address this research need. Until results from this project become available, it will not be possible to include a soil factor in equations for predicting runoff.

3.2.3 Determining the effects of stubble and pasture cover on runoff and erosion

Improved cover was seen as a means of reducing the requirement for banks. Information on cover standards is required for extension.

At present there are no plans to conduct research on cover standards for water erosion control. Some data from the literature could be used for extension purposes while some information on the local situation is determined from rainfall simulator runs. Data in the literature have been obtained using rainfall simulators/ small plots and catchment studies. The work of Lang (1979) and Lang and McCaffrey (1984) could be extended, although the results were obtained from tussock grasses.

3.2.4 Measuring the amount of soil loss that occurs in agricultural areas

Three respondents thought the most important deficiency in our present knowledge was soil loss rates under current management.

A number of projects have attempted to measure soil loss in Western Australia. These have included the use of a truncometer and elutriator (Marsh), sediment samplers in gauged catchments and contour bays (Bligh), profilometers and erosion pins in horticultural areas (McFarlane), surveys after major erosion events (McFarlane and Ryder 1987, Bligh 1987) and the use of Csl37 (Loughran et al. 1986). The data from these surveys has never been integrated and extended. However the data is not very systematic or comprehensive making it difficult to draw general conclusions. There was an intention to equip all gauged agricultural catchments with pumped sediment samplers, but this proved to be prohibitively expensive. Tentative proposals have been made to carry out surveys of soil accumulations in dams, level banks and other sediment traps to gain an overview of soil loss rates. The possibility of the wider use of Csl37 is currently being investigated.

3.2.5 Determining the effects of different tillage methods and intensities on runoff and erosion

The effect of minimum tillage on runoff and erosion on farm sized plots needs to be quantified. Respondents wanted to know whether good agronomic techniques can replace the need for earthworks in some situations.

This deficiency will be partially overcome by trials being conducted by K. Bligh at West Dale, Chapman Research Station and Berkshire Valley. Preliminary results should become available in 1988.

3.2.6 The design of soil conservation structures

The relatively low ranking of this research area probably reflects the availability of the new Soil Conservation Earthworks Design Manual. It was of interest that no respondents mentioned a need for research on waterways. A computer program for designing structures was seen to be a priority by some respondents. The consequence of wider spacings and larger and longer level banks was seen as a research need, as was determining the effectiveness of level working lines. The relative merits of high initial cost level banks (requiring little maintenance) versus small banks was a research priority identified by one respondent. This analysis could be carried out using the BANKS model as has been carried out for grader and bulldozer built drains (Salarian and McFarlane 1987b). A technique to quickly evaluate new structures where events occur only very rarely (e.g. once every 20 years) was another identified research need.

3.3 Waterlogging

The survey listed eight topics for research in waterlogging. The topics fell within three main areas; rainfall/soils, drainage and agronomy. The results for the three methods of rating the priorities are given in Table 3.2.

Table 3.2. Research priorities in waterlogging measured by three methods

		Priority	
Research topic	**Unweighted first**	**Unweighted top three**	**Weighted top three**
Effect on yield	1	1	1
Susceptibility of soils	2	2	2
Design of drains	3	3	3
Cost effectiveness of drains	6	4	4
Rainfall	4	5	5
Biological mechanisms	5	6	7
Computer model	7	7	6
Other	8	8	8
Nitrogen additions	9	9	9

3.3.1 Discussion of priorities

1. Determining the effect of waterlogging at different growth stages on crop yield under saline and non-saline conditions

This research topic received widespread support and topped all three rankings. The early planting of crops to avoid waterlogging is loudly promoted by advisers but there is insufficient information in this area.

The relating of crop yields to waterlogging events in the field has been difficult because the intensity of waterlogging is difficult to quantify and waterlogging interacts with other variables such as salinity and nutrition to affect plant yield. It is hoped that the advent of continuous water level recorders and the recognition of interactions will enable predictions to be made of the effect of waterlogging on yield.

2. Determining the susceptibility of soils to waterlogging

This research topic was widely chosen as a surrogate for determining the extent of the waterlogging problem in the districts. There was a general feeling that waterlogging is very important but nobody can yet quantify the importance of the problem. Susceptible areas should be identified and recommendations made for the area (e.g. drainage, pasture, leave undeveloped).

The extent of waterlogging in the Upper Great Southern is being examined in a Wheat Industry Research Committee of Western Australia project. The extent will be estimated by remote sensing and statistical methods, and waterlogging occurrence will be related to soil types. Remote sensing methods of monitoring waterlogging are also being evaluated in the Esperance area. Some data on the susceptibility of duplex soils to waterlogging is being collected as part of a Barley Industry Research Committee of Western Australia (BIRC) project due to be completed in 1987.

3. The design of drains for waterlogging control

Drain design was seen as being a well developed science in the literature but local drains are not being objectively designed. One respondent identified a need for draining duplex soils where the clay was deeper than 45 centimetres. A technique for draining hillside seeps into dams used for watering stock was another identified need.

The BIRC project will provide some objective data for the design of seepage interceptor drains and there are several research projects on the design of drains for flat land. However scope exists for much more effort in this area. Given the variability of waterlogged sites and the need to collect data over a number of years, a large number of drainage trials is probably warranted. However extensive monitoring programs often produce results, which are difficult to interpret due to insufficient information having been collected. A compromise between extensive and intensive investigations is clearly needed.

4. Estimating the cost effectiveness of drains using existing information

One senior adviser commented that he is yet to see an exercise in estimating the cost effectiveness of a drainage system done by the Department of Agriculture. This situation may change now that the "DRAINS" spreadsheet model (Salerian and McFarlane 1987b) is available. An early version of the model did not allow for the effect of the drains on pastures to be included but a later version has rectified this deficiency. Feedback is required on how suitable DRAINS has been for meeting this research need. Additional research data is required to improve the model's accuracy. Model runs have evaluated which parameters most affect the cost-effectiveness of drains (Salerian and McFarlane 1987b).

5. Analysing rainfall characteristics (likelihood of waterlogging etc.)

This research area was seen as another means of determining the extent of waterlogging in a district (i.e. a similar objective to priority (ii". A method for estimating the probability of waterlogging using rainfall deciles has been developed (McFarlane 1986) and local decile data have been sent to most district offices. To date, only the Northam office appear to be using the data. As the method is somewhat subjective, its use is illustrated in Section 4.

6. Other

Other areas of waterlogging research identified by respondents included:

- The development of waterlogging tolerant crop varieties and crop and pasture recommendations for waterlogging-prone areas.
- Agronomic solutions.
- Ripping and gypsum. Deep ripping of shallow duplex soils is being evaluated in Victoria. Contact has been established with these workers.
- The effect of level banks on recharge and downslope waterlogging. The effect of level banks on recharge at Narrogin has subsequently been determined (McFarlane et al. 1986). Further information is required from lower rainfall districts.
- The effect of waterlogging on the rise of water tables and the consequent spread of salt on flat and sloping sites. Current research at Toolibin, Nugadong, East Perenjori, Esperance and Merredin will provide some information in this area.
- The control of water on hillslopes to prevent waterlogging of lower lying areas. Research at East Perenjori and Narrogin is occurring in this area.

3.4 Flooding

In the survey, an attempt was made to differentiate between storm flood events which cause structural damage (dynamic flooding) and surface ponded water (static flooding). The latter form of flooding can be considered a form of waterlogging in that the root zone of plants can become anoxic.

The research priorities for dynamic flooding included five topics in two areas; rainfall/runoff and flood control structures. The results are given in Table 3.3.

Table 3.3. Research priorities in dynamic flooding measured by three methods

		Priority	
Research topic	**Unweighted first**	**Unweighted top three**	**Weighted top three**
Structure design	1	1	1
Catchment characteristics	3	2	2
Rainfall	2	4	3
Cost effectiveness of banks	4	3	4
Other	5	6	5
Computer model	6	5	6

3.4.1 Discussion of priorities

1. The design of structures to control dynamic flooding

Local design criteria were seen to be a priority. In the Merredin area, level banks are required to fulfil a dual role of flood prevention and water erosion control. A need is seen for a lower cost method of controlling water erosion in the absence of a flooding problem. More knowledge is required on design limits and safety margins for flood control earthworks. Current advice on structures for controlling flood runoff was thought to be poor and there is a need for recommendations to take account of differing soil types and seasonal conditions.

While design methods currently exist for level banks (Davies and McFarlane 1986), there is a need for more hydraulics modelling of the flow around the ends of level banks. Computer modelling to determine the optimal location of flood control structures received a low priority in the survey. The use of the RORB model to simulate the effect of banks and dams on flood peaks on the

Cowcowing, Merredin and Nugadong catchments is providing some insights into dynamic flood control methods. A DRM Technical Report on these studies is currently being written.

2. Determining the catchment characteristics which most influence dynamic flooding

A better knowledge of flooding processes was seen as a prerequisite to developing low cost solutions to the problem and for deciding where structures should be built. Dynamic flood events were considered likely to become worse when rising water tables reach the ground surface and produce base flows.

The NSCP project to determine runoff mechanisms on agricultural catchments (mentioned in Section 3.1) will provide some information on flood runoff mechanisms. This may meet some of the needs, which have been identified.

3. *Analysing rainfall characteristics (likelihood of flooding etc.)*

This area was given priority as it helped establish the importance of the problem and determine whether costly control methods are warranted. A link between rainfall intensity - duration - frequency data and historic flood events would need to be established before rainfall data could be used for predictive purposes. A section of the survey requested details of historic flood events in each district.

4. *Estimating the cost effectiveness of structures to control dynamic flooding using existing information*

Flood control structures are costly and the benefits of flood control/ without surface drainage of local waters/ has not been fully investigated. There is a need for economic information to deter some landholders from wasting money on flood control structures for a problem with a long return period.

5. *Others*

- Design of structures to withstand (as distinct from store) dynamic flooding.
- The magnitude of the problem.
- Farm planning to minimise damage to farm structures.

The research priorities for static flooding (ponded water) included four topics in two areas; rainfall/runoff and flood control structures. The results are given in Table 3.4.

Table 3.4. Research priorities in static flooding measured by three methods

	Priority		
Research topic	**Unweighted first**	**Unweighted top three**	**Weighted top three**
Catchment/ soil characteristics	1	2	2
Cost effectiveness of drains	2	3	1
Structure design	3	1	5
Rainfall	4	4	3
Other	5	5	4

3.4.2 Discussion of priorities

1. *Determining which catchment/soil characteristic most influence static flooding*

Information was needed on where the problem will occur and where the water comes from which causes the problem (i.e. local or foreign water or both). This information is needed prior to design. Like waterlogging, static flooding is perceived as a large but ill-defined problem in many districts.

2. *Estimating the cost effectiveness of structures to control static flooding using existing information*

V and W drains (random and parallel) and laser levelling have been used for some time but the cost effectiveness of these treatments has not yet been assessed. The DRAINS spreadsheet model is suitable for determining the long term cost effectiveness of V and W drains. However the benefits of drainage (required for the model) are rarely measured.

3. *The design of structures to control/remove static flood waters*

Data are required for the objective design of drains for flat lands. There is a need for more trials work in this area. One respondent thought most people know what needs to be done about surface flooding while another was concerned that the recommendations had not changed in many years, reflecting a lack of research in this area.

4. *Other*

These include:

- The use of soil conditioners (e.g. gypsum) on clay flats. Martin Howell at Merredin is examining this aspect.
- A comparison of existing surface drainage machinery and the design of better machinery.
- 0The control of water on the slopes above flat areas. The RORB model can calculate the effect of banks, dams etc on flood volumes as well as on flood peaks. A forthcoming DRM Technical Report will address this problem.

4. Documentation of Historical Events

The survey asked for information on historical erosion, waterlogging and flooding events. This data provides a valuable record of the frequency of these events in different parts of the agricultural area.

Sufficient data were collected from three districts to determine the frequency of "waterlogging years" (subjective definition) in the districts. These data have been plotted onto the probability distribution for different monthly rainfall amounts (Figure 4.1).

The figure shows an apparent increase in the frequency of widespread waterlogging from Northam (once every seven years) to Narrogin (twice every five years) to Esperance (four years out of five). The frequency of waterlogging in susceptible parts of these districts will be much higher than these estimates. Similar analyses would need to be carried out for each individual site before recommending drainage, (McFarlane 1986).

5. Conclusions

Waterlogging was identified by District Office staff as being of major importance in agricultural areas of south western Australia. Water erosion and flooding were seen as being of major importance in some districts.

The survey has revealed a number of research priorities in water erosion, waterlogging and flooding. Current and planned research will meet some of these requirements. The survey has also revealed areas where research results have not been adequately extended to country-based staff. In some areas there is a need to collate the results of research for extension purposes.

The research areas that were identified in the survey are summarised in Table 5.1.

Table 5.1. Major research priorities identified by country-based staff in May 1986 (and not subsequently carried out).

Water erosion	1. Soil erodibility and runoff mechanisms
	2. Stubble and pasture cover standards
	3. Amount of soil loss
Waterlogging	1. Effect of waterlogging on yield
	3. Extent of the problem
	3. Design of drains
Dynamic Flooding	1. Design of structures
	2. Catchment characteristics
Static Flooding	1. Catchment/ soil characteristics
	2. Design of structures

Data were collected during the survey on which soil/landforms most experience water erosion, waterlogging and flooding, along with information on historic events. This information will help research officers better target their effort.

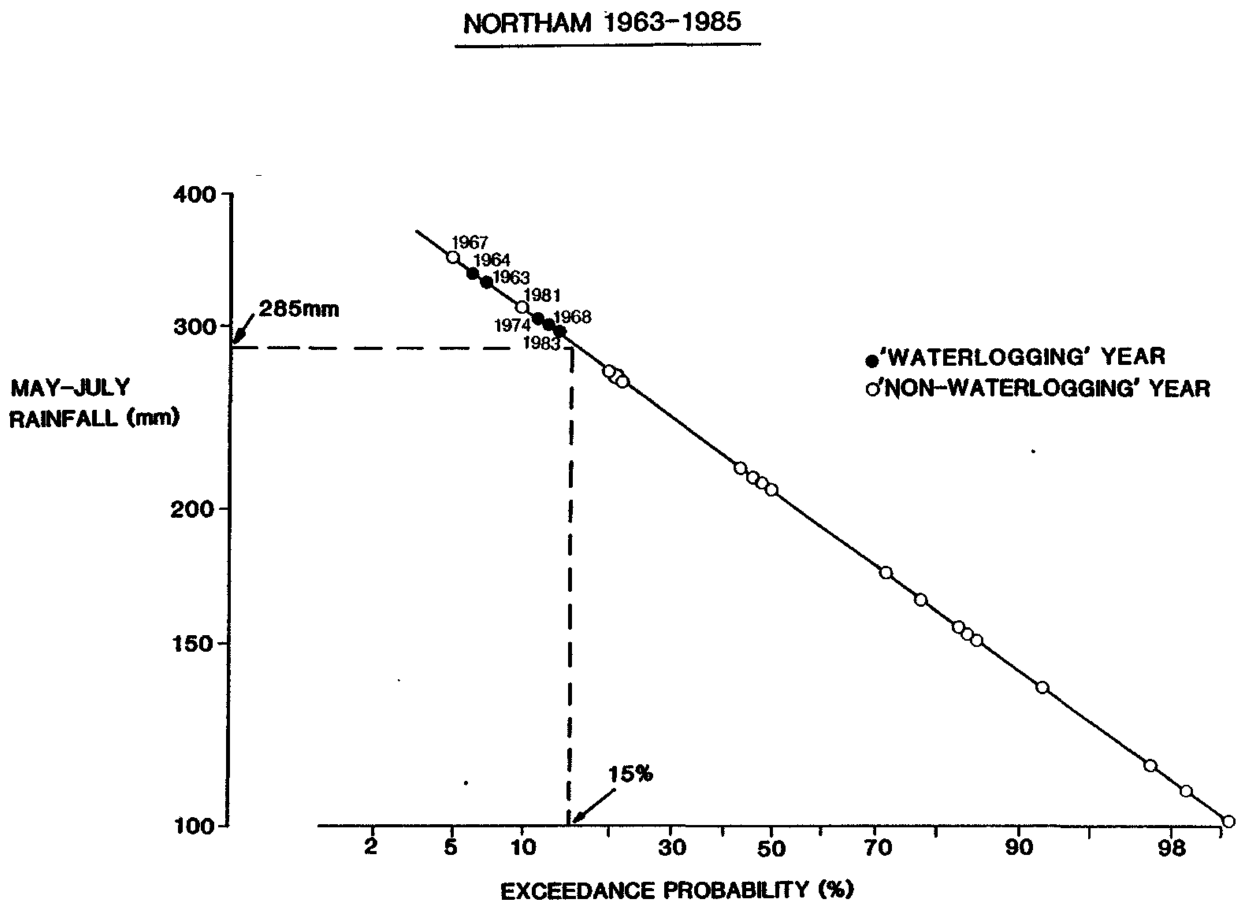

Figure 4.1a Probability of widespread waterlogging in the Northam district

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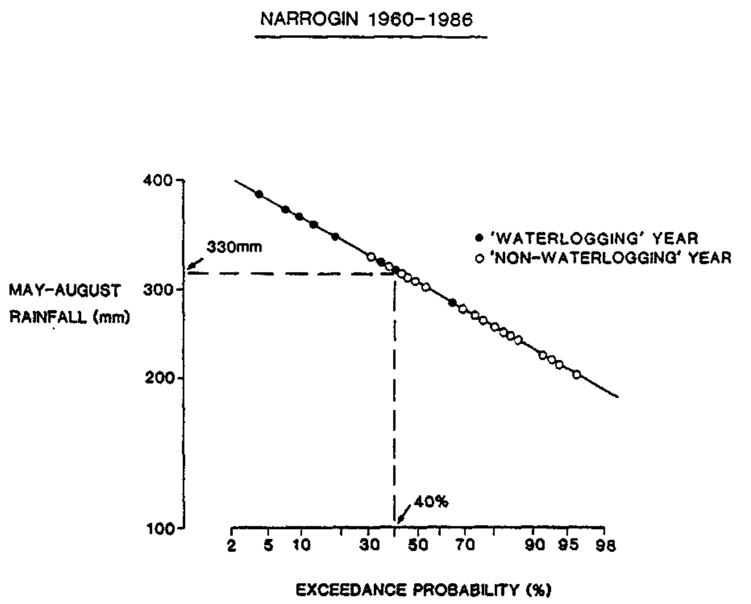

Figure 4.1b Probability of widespread waterlogging in the Narrogin district

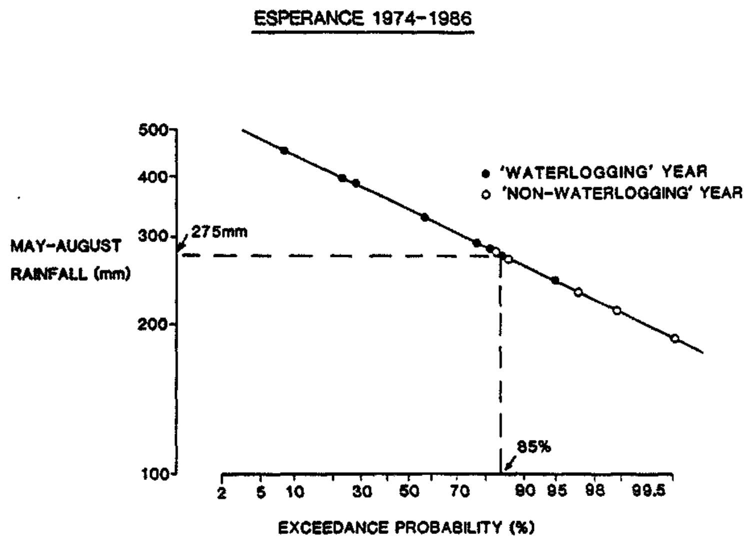

Figure 4.1c Probability of widespread waterlogging in the Esperance district

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6. Recommendations

It was clear from a number of the comments made by respondents in the survey that they were unaware of some research results, which had been obtained several years previously. A major recommendation is that the extension of research information to advisers and technical officers be improved.

Often the results that do get to district offices are piecemeal and there is a need for occasional review papers to collate the research information. Seminar papers at head office have recently reviewed the hydrology and agronomy of waterlogging. It is recommended that these papers be integrated and sent to district offices. A review of wheatbelt flood studies is also in preparation as a DRM Technical Report. This report should review much of what is known about flooding and its control. There is a need for a similar review of water erosion research (possibly similar to the review of wheatbelt salinity carried out by Malcolm (1983)). Information obtained subsequent to the reviews should be forwarded to district office libraries and eventually incorporated into updated reviews.

With regard to future research on water erosion, the following is recommended:

1. The importance of soil properties (e.g. non-wetting, water storage, surface sealing) affecting runoff and soil loss on agricultural catchments should be quantified. This analysis should be carried out on the gauged agricultural catchments for which historic flood events have been recorded. The rainfall simulator should be used on the catchments to characterise the soils and to enable soils in ungauged catchments to be similarly characterised to help extend the results.

2. Data should be collected on the effect of vegetative cover on runoff and soil loss. This information should come from:

- rainfall simulator runs to provide an appreciation of processes (e.g. the relative effectiveness of grasses and broad leaf pastures, the relative importance of attached and prostrate stubble).
- the effect of vegetative cover on runoff on the gauged contour bay catchments should be separated from tillage effects if possible.
- the amount of vegetative cover on the gauged agricultural catchments could be estimated from climatic data once a pasture growth model has been adequately developed by Plant Research Division. This variable could then be added to the factors used to predict historic flood runoff events.
- data from the literature should be critically reviewed.

3. The following methods should be used to estimate soil loss:

- Cs-137 methods should be used in representative parts of the agricultural areas to determine overall soil loss rates during the past 30 years.
- data should continue to be collected from rising stage samplers on the gauged catchments.

- the effect of tillage on soil loss should be determined from the contour bay studies at West Dale, Berkshire Valley and Chapman.
- measurements of soil losses and accumulations after major storms should continue.
- the possibility of measuring soil accumulations in dams, which have not been cleaned for a number of years, should be investigated, as should the establishment of datum's (e.g. erosion pins, marks on rock heaps) in agricultural areas.

4. Trials on the effect of sheet erosion on crop productivity should be recommenced in conjunction with wind erosion research workers.

With regard to future research on waterlogging, the following is recommended:

1. The effect of waterlogging on crop and pasture yields should continue to be assessed in the glasshouse, in controlled plots and in the field. In addition it would be desirable to determine how waterlogging affects the species composition of pastures. Special emphasis in these studies should be placed on quantifying the interactions between waterlogging and other stresses (e.g. low levels of salinity, nutrient deficiencies, drought and disease). The quantification of these interactions will frequently require the collection of a wide range of plant and soils data. Depending upon the aims of an experiment, it might be necessary to make detailed assessments at one or more times during the growing season of perched water tables, soil oxygen concentrations, soil redox potentials, soil salinity, soil moisture, soil nutrient status, shoot growth, root growth and distribution, plant nutrient and salt content, plant water relations, and root and leaf disease symptoms.

2. The extent of waterlogging and the susceptibility of soils to waterlogging need to be determined for years with differing rainfall amounts and distribution to enable the importance of the problem to be determined. This requires a rapid and routine method of mapping waterlogging be developed. To cover large areas, satellite remote sensing appears to be the best option.

3. While a quantitative method of designing seepage interceptor drains needs to be developed, of more importance is the evaluation of drains for clay flats for which little data have been collected. Controlled trials of drains on differing spacings need to be set up on typical clay flats. Monitoring drain flows is probably not realistic, but drain performance can be assessed by crop yield measurements (which also provides information for extension). Care must be taken to determine whether salinity, nutrition or disease affected crop yields on the sites. The costs and benefits from drainage of clay flats should be compared with the costs and benefits of using gypsum (and of using drains and gypsum).

4. More detailed soil water investigations are required to understand and quantify the waterlogging of duplex and clay soils. The possibility that preferred pathways are becoming blocked in duplex soils after clearing needs to be investigated, as does the effect of soil structure on soil infiltration rates. Detailed monitoring of the perched aquifer in duplex soils is now possible with capacitance probes and data

loggers. The spatial distribution of perching may also be determined by ground probing radar (Asmussen et al. 1986).

5. Notwithstanding the very low priority given in the survey to the selection and breeding of cereals for waterlogging tolerance, we feel that there could be considerable economic gains to be made from such a programme. Recent studies by Thomson, Leighton, Barrett-Lennard and Greenway (unpublished) have highlighted the importance to waterlogging tolerance of the rapid development of crown roots and first, second and third order lateral roots. Furthermore, the rapid development of these roots seems to be linked with rapid shoot development (Klepper et al.. 1984). Thus it is likely that a screening of cereals for rapid shoot development (i.e. short phyllocron interval) may produce cultivars with substantial waterlogging tolerance.

With regard to future research on dynamic flooding, the following is recommended:

1. While the RORB model should continue to be used to route flood flows in large catchments, the use of kinematic wave models (e.g. Stephenson and Meadows 1986) should be investigated for assessing flows around bank ends etc.

2. Future dynamic flood events should be well documented to help determine the return period of damaging floods in large catchments and to provide some data for calibrating the RORB model. Catchment contours should be improved (using the Australian Survey Office wherever possible) to enable calculated flood flows to be distributed over the ground surface using backwater programs. The improved contours will also improve the design of levee bank systems.

With regard to future research on static flooding, the following is recommended:

1. Attempts need to be made to quantify the source of ponded water in catchments after a storm. If the infiltration function of soils on a flat can be determined using the rainfall simulator, the likelihood of ponding for storms with differing return periods can be assessed. If there is more water present than can be accounted for from in situ rainfall, the presence of runoff and/or seepage waters will have been indicated. Alternatively, runoff volumes for storms with differing return periods can be estimated using the RORB model and the volumes converted to depths to estimate whether foreign waters are likely to be important.

2. (ii) Data is required on the cost effectiveness of open drains installed to remove ponded water.

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9. Appendix 1 Survey form

9.1 Survey Of Research Priorities In Water Erosion, Waterlogging And Flooding

The Division of Resource Management has recently formed two new functional groups, the Water Erosion, Waterlogging and Flooding Group (Don McFarlane, Kevin Bligh and Jim Davies (30% of time)) and the Waterlogging and Drainage Group (Ed Barrett-Lennard, Ross George and Penny Leighton). The inclusion of waterlogging in the brief of both groups is in recognition of the importance of shallow subsurface hydrology in both surface and groundwater hydrology processes.

As part of the Corporate Plan for the Department of Agriculture, it has been necessary to outline research programmes in water erosion, waterlogging and flooding for the next five years. To ensure that country-based advisers and technical officers have input to the plan, a survey is enclosed which asks you to give priority to the research which will provide answers to the most important problems which you face. At the same time we are asking you to document historical events so that we can better determine the return period of these three problems in your area. Finally we are asking you to list the most important soils/landscapes which result in water erosion, waterlogging and flooding in your District (or in a District in which you have worked).

As there is some difficulty in separating the three problems in many areas, the terms are defined below:

Water erosion: sheet, rill and gully erosion by runoff waters.

Waterlogging: saturation of part or all of the root zone of crops and pastures.

Flooding: A. Dynamic - uncontrolled storm runoff which damages roads, railways, buildings, fences, crops etc.

B. Static- surface ponded water.

We ask you to take the time to fill in the survey carefully as it will help to guide research in these areas for the next five years. If you need any help in completing the survey we can be contacted on 368 3656 (McFarlane) and 368 3279 (Barrett-Lennard). We hope to be able to circulate the results of the survey to you in the next few months. Thank you for your help.

Don McFarlane,
Ed Barrett-Lennard,
Research Officers,
Division of Resource Management.
May 1986.

9.2 General Statement:

Do you regard water erosion, waterlogging and flooding to be important problems in your District? Please rate the importance from 1 (extremely important) to 7 (not important at all).

Water Erosion:

Waterlogging:

Dynamic Flooding:

Static Flooding:

Name: District:

9.3 *Research Priorities*

Please number your priorities from 1 (highest). It is not necessary to number all the points. If necessary the highest priority can be shared by more than one area.

A. Water Erosion **Priority**

- Analysing rainfall characteristics (likelihood of erosive storms etc.)………………..
- Determining the susceptibility of different soils to detachment and erosion………..
- Understanding run-off mechanisms……………………………………………….
- The design of soil conservation structures ……………………………………….
- Carrying out field evaluations of new structures (water spreaders, broad-based banks etc.)……………………………………………………………………………….
- Estimating the cost-effectiveness of soil conservation structures using existing information. ………………………………………………………………………
- Building a computer model to predict runoff and soil loss under different conditions……………………………………………………………………………..
- Determining the effects of different tillage …………………………………………..
- Determining the effects of stubble and pasture ……………………………………
- Determining the effects of soil loss on crop ………………………………………...
- Measuring the amount of soil loss that occurs ……………………………………..
- Determining the rate of recovery of soils from ……………………………………..

Justification For First Three Choices

1.

2.

3.

If insufficient room, please attach additional notes.

Please number priorities from 1 (highest). It is not necessary to number all the points. If necessary the highest priority can be shared with more than one area.

B. Waterlogging **Priority**

- Analysing rainfall characteristics (likelihood of waterlogging etc)………………..
- Determining the susceptibility of soils to waterlogging……………………………
- The design of drains for waterlogging control……………………………………….
- Estimating the cost-effectiveness of drains using existing information…………
- Building a computer model to predict waterlogging and to optimise drain spacings
- Determining the effect of waterlogging at different growth stages on crop yield
    - Under non-saline conditions……………………………………………….
    - Under saline conditions ……………………………………………….
- Understanding the biological mechanisms whereby waterlogging results in lower crop yields
    - Under non-saline conditions………………………………………………..
    - Under saline conditions……………………………………………………..
- Determining whether late applications of nitrogen fertiliser can overcome the effects of waterlogging……………………………………………………………….
- Others (please state)……………………………………………………………….

Justification For First Three Choices

1.

2.

3.

Please number priorities from 1 (highest).

C. Flooding **Priority**

1. Dynamic Flooding (Peak Flows)

- Analysing rainfall characteristics (likelihood of flooding etc.)…………………….
- Determining which catchment characteristics most influence dynamic flooding

- The design of structures to control dynamic flooding……………………………..
- Estimating the cost-effectiveness of structures to control dynamic flooding using existing information…………………………………………………………………..
- Computer modelling to determine the optimal location of dynamic flood control structures……………………………………………………………………………….
- Others (please state)………………………………………………………………….

Justification For First Two Choices

1.

2.

Please number priorities from 1 (highest)

2. Static Flooding (Ponded Water) Priority

- Analysing rainfall characteristics (likelihood of flooding etc.)……………………..
- Determining which catchment/soil characteristics most influence static flooding
- The design of structures to control/remove static flood waters…………………..
- Estimating the cost-effectiveness of structures to control static flooding using existing information………………………………………………………………….
- Others (please state) ……………………………………………………………….

Justification For First Two Choices

1.

2.

List Of Important Soils/Landscapes Which Commonly Experience Water Erosion, Waterlogging And Flooding.

If you are familiar with the classification of soils/landscapes used in the draft publication by Carder and Grasby, use these classifications.

District:

1. Water Erosion

Rank	Soil	Landscape Position	Problem	Solution Available?
(eg 1	Non-wetting sandy loams	mallet hills, high slopes)	gullying	absorption banks

2. Waterlogging

Rank	Soil	Landscape Position	Solution Available?

3. FLOODING Indicate Whether It Is Dynamic (D) Or Static (S) Flooding Or Both (B).

Rank	Soils	Catchment Characteristics	Solution Available?

If insufficient space, please attach additional notes.

Documentation Of Historical Events

List the most important events in your District (or in a District with which you are familiar) in order of decreasing importance. Where possible indicate the month(s), which were most important.

District:

1. Water erosion during 19 to 19 .

Year	Month(s)	Widespread or local?	Severe, moderate, mild?
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

2. Waterlogging during 19 to 19 .

Year	Month(s)	Widespread or local?	Severe, moderate, mild?
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

3. Water erosion during 19 to 19 .

Indicate whether it was dynamic (D) or static (S) flooding or both (B)

Year	Month	(Days)	Widespread or local?	Severe, moderate, mild?
1.				
2.				
3.				
4.				
5.				