

Progress report on
**National Soil Map of
Zambia**
scale - 1 : 1 mill

with comments about the other
mapping programmes.

The Soil Survey Unit, Zambia
(NORAD Project ZAM-009)



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Consultancy for **NORAGRIC** , NLH, Ås

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I Preface.

This report is an analysis of the progress regarding the Soil mapping programmes carried out at the Soil Survey Unit (SSU), Government of the Republic of Zambia. As stated in the Terms Of Reference (Appendix Ia), major emphasis has been put on the National Soil Map, scale 1 : 1 mill.

The consultancy contract was signed on 8th November 1989 (Appendix Ib).

The field study was carried out between November 19th and December 7th at the Soil Survey Unit headquarters at Mount Makulu Central Research Station, Chilanga, Zambia. A total of 21 days were used, including travelling time. In addition some days were used at the Agricultural University of Norway, to finish the report.

I would like to thank all staff at the Soil Survey Unit, the cartographers at Land Use Branch, Ministry of Agriculture and Co-operatives (MAC); the staff at Cartographic Section, Survey Department, Ministry of Land and Natural Resources (MLNR), and the staff at NORAD / Lusaka for all support and cooperation during my stay in Zambia.

I would also like to express my gratitude to Olav Hesjedal, Institute for Environmental Analysis, Bø, and to Calle Hedberg, Institute of Informatics, University of Oslo, for giving me copies of their SSU review reports. Calle Hedberg provided me with copies of several 'End of contract reports' before I traveled to Zambia, and a Soil map which I did not find at Mt. Makulu. He has also read a draft of this report and suggested improvements. Last but not least; Thanks to Mr. Roman Raemakers, Plant Pathology Section at Mt. Makulu, for allowing me the use of their computer-facilities for making notes and drafting this report.

Text and all figures except the frontpage SSU symbol, have been produced by me. With regard to the text, I would therefore like to apologize for any deviation from Oxford English.

I also want to thank NORAGRIC for their patience because of the delay in report completion.

Ås - NLH, 31. January 1990.

Rolf Sørensen

II Summary with Conclusions

The objective of the consultancy has been to review progress of the National Soil Map of Zambia, scale 1 : 1 mill., in relation to the workplans set up by the "Hesjedal report". This task was carried out during a three weeks visit to Zambia in November / December 1989.

The Provincial Soil Mapping programme which is the basis for the National Soil Map, are on an average ahead of schedule, with approximately 85 % of the Zambian territory mapped. The results are presented on maps and with accompanying memoirs for five Provinces. Of the remaining four Provinces, draft maps for Lusaka and Central Provinces were almost finished at the end of 1989. The mapping of Southern Province will be finished at the beginning of the dry season 1990, the Western Province *must* be finished by July, and the final maps for the two provinces will be ready at the end of August 1990.

There will be no need for expert help from outside, for the completion of the National Soil Map programme for this part of the production line. The completion of the Western Province Soil Map must follow the new time-schedule set up in this report.

Before the drawing of the four National Soil Map sheets can start, the Map Legend must be established. This work has been postponed for varying reasons. However, since only approximately 15 % of Zambias area remains to be mapped for the National Soil Map programme, it should not be a scientific problem to work out the final Legend immediately.

On the contrary, the National Legend must be created as soon as possible, otherwise this will create a serious bottle-neck.

With the present staff at Cartographic Section, LUB, it will be impossible to manage all the work with the National Soil Map, in addition to similar work with Soil Maps for four Districts, and the other regular work.

It is therefore the reprographic work which will be the real bottle-neck in the production line for the National Soil Map of Zambia.

Several steps in the reprographic process requires co-operation between the Cartographic Sections at Land Use Branch and the Survey Department. This co-operation has gone very well so far. The preparation of four National Soil Maps and four District Soil Maps will cause a considerable increase in work over a period of at least one year. The need for good coordination will be imperative during this phase of the work.

It will not be possible to complete the National Soil Map without strengthening the Cartographic Section. LUB, with one experienced cartographer for a period of at least one year.

According to the consultancy on printing (Lie & Sørensen 1990), it will be possible to print the four multi-coloured sheets of the National Soil Map at Government Printer, Lusaka. However, I believe that it is necessary to print most of the District Soil Maps first, and thereby gain needed experience.

The progress of the National Soil Map cannot be looked upon separately. All the other running programmes at SSU and the Cartographic Sections at LUB. and SD. must be taken into account. Although it was not stated in my Terms of Reference, I have also looked into the progress (or lack of it) regarding the District Soil Maps and the ordinary Soil Survey Reports and Maps.

One of the District Soil Maps is ahead of schedule, but the other four have a backlog of 2 - > 5 months, compared to the Hesjedal report. The most serious effect of this is that the District Soil Maps will be ready to enter "the reprographic phase" at the same time as the National Soil Maps. This will enhance the bottle-neck at the Cartographic Section, LUB. Secondly, the reports accompanying the District Soil maps will be ready at almost the same time, and this may create a bottle-neck in the word-processing phase.

The discrediting "backlog" of the Soil Survey Maps and Reports is more complex than the presentation given by Hesjedal. Between 10 and 14 reports are either taken abroad for completion in 1988 by Mr. C.Parker, former Soil Surveyor in North-Western Province, or they have never been produced! The Soil Correlator promised to send me a revised list of the so called backlog. The draft of this list was presented at the meeting between the SSU staff, T. Larsen, NORAD, and me at Mt. Makulu just before my departure. Except for the reports where C.Parker is author, the backlog today is far less serious than expressed in the Hesjedal report.

The work of the **Project Coordinator** will be imperative for the implementation of all the different parts of the production lines, both for the District - and the National Soil Map, as well as for the "backlog" in Soil Survey Reports.

Many people have been working well together upto now. In the process of finalizing the remaining four District Soil Maps, and the National Soil Map, coordination is a key word if the tight time-schedules shall be followed. The communication lines must therefore be held open at all times, so that possible bottlenecks can be eliminated immediately.

Final conclusion:

The National Soil Map can be completed by the end of 1991 on certain conditions mentioned below;

1. As mentioned above, the pile-up of work at the Cartographic Section, LUB, will come to effect already from the middle of 1990. This must be taken care of by employing an extra cartographer as soon as possible
2. The new time-schedules set up in this report must be followed, and this implies that no unexpected events will occur, all steps in the production line will run smoothly, and that all staff concerned will stay on to the end of the project. Some of the staff regard this as a bitter end, because of the "phase out" decision.

III. Recommendations

The National Soil Map of Zambia:

Before the drawing of the four sheets of the National Soil Map can start, two steps must be taken simultaneously;

It is necessary to do *some* simplifications on the most intricate polygons, and that the smallest ones should be erased. However, some of the very small polygons may enclose an important soil type, and then it would be wrong to erase it. Where two mapping units inter-finger in a close network it may be better to join the two into an association. One must also be realistic about the "purity" of each mapping unit. The smallest polygons presented on the Provincial maps are certainly smaller than some "inclusions" in the largest polygons. There must be a reasonable balance in "map reliability" on the whole National Soil Map. The suggested adjustments will improve the readability of the map, it will make "line-work" a bit easier for the cartographer, and it will definitely make the "peel-coat" work and proof-reading less cumbersome.

The other, and equally important step, is to set up a National Legend. When a draft is ready, I would suggest that a Work-shop on the final Legend should be held, for instance at UNZA, with an invited specialist as a consultant (Dr. F.N. Muchena - former Head of Kenya Soil Survey has been mentioned).

Either the draft, or the final product could be presented at the planned African Soils Correlation Meeting (in Nairobi - or elsewhere ?).

Suggestions for the Legend layout are given in the Appendix.

An Editorial Committee should be established for the writing of the Report / Memoir accompanying the National Soil Map of Zambia. They should elect an Editor in Chief. When the draft is ready, copies should be distributed to pre-selected referees for constructive criticism and comments.

Some suggestions for the content of the Report / Memoir are given in an Appendix

The real need for qualified assistance lies on the cartographic / reprographic side.

In order to handle all the additional reprographic work at the Cartographic Section, LUB, it will be necessary to employ an extra cartographer for a period of at least one year, starting from the middle of 1990. I believe that qualified cartographers can be found in Zambia, either in the state - or the private sector. Advertizing for such a person must be started as soon as possible. If it should prove difficult to find a cartographer in Zambia, a "head-hunting" mission in the neighbouring countries must be arranged.

There will be need for a good archive system when all the "peel-coats" from four District Soil Maps, and the four sheets of the National Soil Map are in the cartographic phase. [There will be approximately a total of 125 peel-coats for the District Soil Maps, and >200 for the National Soil Map].

The District soil Maps

The District Soil Maps with addition of the new Land Evaluation System are likely to be the most interesting SSU-product in the future. It is therefore important to give much attention to the presentation of both the maps and the memoirs, i.e. to make them "user oriented". The map legend should put less importance on taxonomy, and more on the agricultural potential of the mapping units, for instance by using an "Extended Legend" in table form.

The reports must reduce taxonomic discussions and present crop suitability maps produced from the Land Evaluation System. Therefore, the Mansa District Soil Report should not be printed before the soil map is digitized and the computerized Land Evaluation maps can be included.

Because of the planned tour to Norway for Government Printer staff, using the Mansa District Soil Map for training, it is important that an other District Soil Map should be ready for printing on their return. Decision regarding which one of the other District Soil Maps that should be made ready for the repro-phase must be taken. The Mkushi Map has been suggested.

Digitizing:

Priority should be given to the five District soil maps, and the Mansa map should be digitized as soon as possible. The computerized Land Evaluation (Crop Suitability) maps could be added to the report accompanying the map (see above).

If the main objective for the National Soil Map programme is to set up *National Development Plans*, then also these four map-sheets should be digitized. With the present time-schedule it is not time enough for a full analysis of map information for presentation of National Development Plans. I suggest that a separate programme for National Soil Map Analysis should be started when the map and memoir are published.

Finally, I recommend that the whole concept of digitizing is discussed thoroughly, and that this topic is taken up by the Information systems consultancy (by C. Hedberg).

Soil Survey Maps and Reports

The newly revised list of "backlog" must be presented as soon as possible, because the backlog reported by Hesjedal was not thoroughly analysed, and it was partly wrong. However, this has given the SSU unnecessary negative reputation, and therefore it should be amended.

This most serious part of the "backlog", the 10 - 14 reports which are lacking, must be cleared up as soon as possible by taking direct contact with the responsible author.

Preliminary "Recommendations" and a "Summary of progress up to date" was presented at Mt. Makulu on the 6th of December 1989, in accordance with the Terms of Reference. The Recommendation part of this is attached as an Appendix

IV Introduction.

The Soil Survey Unit (SSU) is at present part of the Research Branch in the MAC. SSU started its operations in 1973 with support from FAO and NORAD. NORAD's support was formalized as a specific development project, ZAM 009, in 1977. The project is now in the latter half of phase III, with phase I covering the period 1977-82 and phase II covering 1983-86.

NORAD has decided to phase out its support by the end of 1991.

Olav Hesjedal, Institute for Environmental Analysis (INA), in his report from April 1989 provided a detailed examination of the project workplan for the remaining project period (1989-91). His findings and recommendations are the basis for my report.

A number of proposals for the future progress presented in my report are directly related to the Hesjedal report, either endorsing his recommendations or suggesting alternative approaches and actions.

The report on the SSU's information systems, presented by C. Hedberg in June 1989, has also been a valuable basis for my evaluation of parts of the SSU mapping programmes.

The Terms of Reference identified the following objectives for the report:

1. To review and assess the state of the National Soil Map Programme and feasibility to complete this by 1991.
2. To assess the need for external assistance as recommended by the Hesjedal Report, 1989.
3. To draw up detailed plans for the successful publication by 1991 of the National Soil Map and accompanying report

However, the other SSU soil mapping programmes will directly or indirectly influence on the progress of the National Soil Map, and I have therefore also looked into the present state and future progress of these.

Detailed cost and time estimates have been left out, i. e. the recommendations must be discussed and if they are accepted in principle, - refined with consideration to the financial constraints in the next two years.

My conclusions with regard to the main points given in the TOR are presented in the *Summary*. Nearly all specific recommendations are in the *Recommendations* part, in addition to being mentioned and explained in the main text. *Chapter 1* gives an overview of the soil mapping programmes. *Chapter 2* describes the different phases in the production line for the National Soil Map, including the accompanying report. *Chapter 3* presents possible constraints in the production lines, and *Chapter 4* presents the detailed workplans for the remaining period.

Background for the National Soil Map programme.

From the establishment of the National Soil Survey Unit, one of the main goals has been to produce a national soil map. At the start of the NORAD engagement with the SSU it was concluded: "The results of the Zambia National Soil Survey primarily are expected to meet the immediate needs for making Regional Development Plans, and secondly to give a complete national soil survey where all areas are covered", (Njøs 1972). During my own service with the SSU (1975 - 77) this was discussed regularly. However, from the start and up-to 1981 almost all the work was concentrated on large scale (semi-detailed and reconnaissance) mapping), and the SSU seems to have lost sight of the second goal.

The Evaluation team from NORAD / MDC (1981) took up this issue again. A special National Soil Mapping programme was started in 1982 with a NORAD recruited staff, and became fully operational in 1985 with the assignment of a Zambian Professional Officer.

In the project review (NORAD / MDC 1985), it is again stated that: "The production of a Soil Map of Zambia scale 1 : 1 000 000, has been one of the main objectives in setting up a Soil Survey Unit right from the start". It was therefore urged to speed up the work on the National Soil Map. At the same time a larger part of the SSU staff went abroad for higher education, and therefore the mapping programmes could not be kept up.

This "flight abroad" and its effects have been discussed by Hesjedal (1989), Hedberg (1989), and others. I agree with the statements in the first part of the "summary" in Hesjedal (1989, p. 9).

Some comments on Exploratory maps in general.

The potential use of exploratory soil maps (scale 1 : 1 mil.) and their limitations, are described in the introduction of all the memoirs accompanying the Provincial Soil Maps (cf. Chileshe 1989). However, the views on the general usefulness of exploratory maps vary. Landon (1984) states that they can be used for: a. Resource inventory, b. Project location, and c. Pre-feasibility studies.

Dent and Young (1981) have a more restricted view and say that they can be used for; a. Display, b. National atlases, c. Teaching, and d. Background for survey preparation - in this order.

It must be realized that "the predictive value" (Dent and Young 1981), of small scale soil maps are negligible, but on the other hand the regional trends in soil distribution can best be visualized on such maps. A situation concerning the Geological Map of the World can also be applied for the present soil map; "Because of their vocation as a synthesis and the great areas they represent on a small surface, general maps will escape, we feel, both short term and long term, from the destiny that awaits detailed maps. -- Therefore, we are resolutely optimistic about the destiny of small-scale earth-science maps, even in the distant future", (Dottin 1989).

The actual potential use of such maps depends on the complexity of soil distribution in the region, population density, agricultural development, and other factors. With the Zambian conditions in mind, I have set up a number of uses which possibly can serve as “guide-lines” (background philosophy) for the completion of the National Soil Map of Zambia.

1. “The objectives of this programme is to produce a soil inventory map (4 sheets, scale 1 : 1 mill) and an interpretative accompanying report, *to be used for national agricultural development planning*” Hesjedal 1989).
2. The need by SADDC to have general information of soil resources, production potential, soil degradation, etc. in the region (Chinene 1988).
3. FAO-Unesco Soil Map of the World needs new input. The new Soil Map of Zambia will be an important contribution.
4. The UNEP - SOTER programme (a global soil database based on polygon descriptions) scaled to 1 : 1 mill maps. With some changes The Soil Map of Zambia will fit into this system.
5. GLASOD - “Global Assessment of Soil Degradation” programme, is based on the SOTER programme. The new Soil Map of Zambia can produce valuable information about the present status of soil and land degradation, and also highlight future problems.
6. The National Soil Map will be an important contribution to the teaching of Soil Science in Zambia. The old Soil Map of Zambia (Brammer 1965) is outdated long ago. Veldkamp (1983 ?) made a revised “Soils Map” of the Republic of Zambia. [I have only seen a reduced edition (scale 1 : 5 mill) with 32 mapping units, dated 1987]. Also this map is too crude for the objectives stated in pts. 1 to 5 above.
7. The National Soil Map is in itself a scientific achievement which will be noticed far outside Zambia.

1. 1. 1. Provincial soil maps - 1 : 1 mill

Four maps and accompanying memoirs were published in 1987 - 88. The fifth (Eastern Province) was presented on the 28. 11. 89. (ahead of schedule !). Four provinces remain to be finished.

The boundaries of provinces and districts are presented on Fig. 2 where the present status of the mapping programme is shown. On Fig.3 a cumulative area-diagramme of the nine provinces show that by the end of November 1989, approximately 56 % of the country was covered by published Provincial soil maps in scale 1 : 1 mill. Interpretation and fieldwork is completed for another 30 % of Zambias total area. Approximately 14 % remains to be mapped. In the work-plan set up for 1990, the SSU expects that all the provinces should have been surveyed by the end of 1990. The other stages of the production are more or less similar to the Hesjedal work-plan.

Revised and detailed plans for the remaining work is presented in Chapter 4.

Today the Provincial mapping programme is on time -, or even partly ahead of the plans set up by Hesjedal, see Fig 1 & 2. Western Province will be discussed separately, see Section 3. 1.

The construction of the Provincial Soil Maps

It is important for the potential users of the exploratory maps to know the method of production. Only then the reliability of the maps can be evaluated.



In principle the maps are produced after the "Land System Approach" (Dent and Young 1981).

Land systems and Land units are defined according to the "Geomorphic legend for Zambia" (Dalal-Clayton et al. 1985), and the delineation of the different units are done by interpretation of "false colour" Landsat 4 and 5 imageries, enlarged to scale 1 : 500 000. The imageries are not geometrically corrected, but they seem to be enhanced in the infrared band, resulting in a better resolution of variation in vegetation and soil moisture.



The next step is FIELD CONTROL (ground thruthing) along easily available traverses, i. e. roads and tracks. General distribution of soils in relation to topography is noted (toposequences). With the addition of existing knowledge about soils in the region (published and unpublished soil data), a DRAFT MAP scale 1 : 500 000 is produced as "overlay" on the satellite imageries. The draft map is photographically reduced to 1 : 1 mill. , and necessary simplifications of map polygons are carried out.

The last step is TRANSFER and adjustment. to available "base maps". The draft map based on satellite imageries is not completely true to scale (geometrically distorted). The transfer to the 1 : 1 mill. base-map is done manually, and adjustments are made mainly through comparing hydrological features. The accuracy of this transfer procedure is considered to be reasonably good, particularly in the high rainfall areas where stream densities are high.

Provinces:

-  Maps and Memoirs published
-  Interpretation and fieldwork completed

Districts:

-  Map ready for printing
-  Fieldwork finished

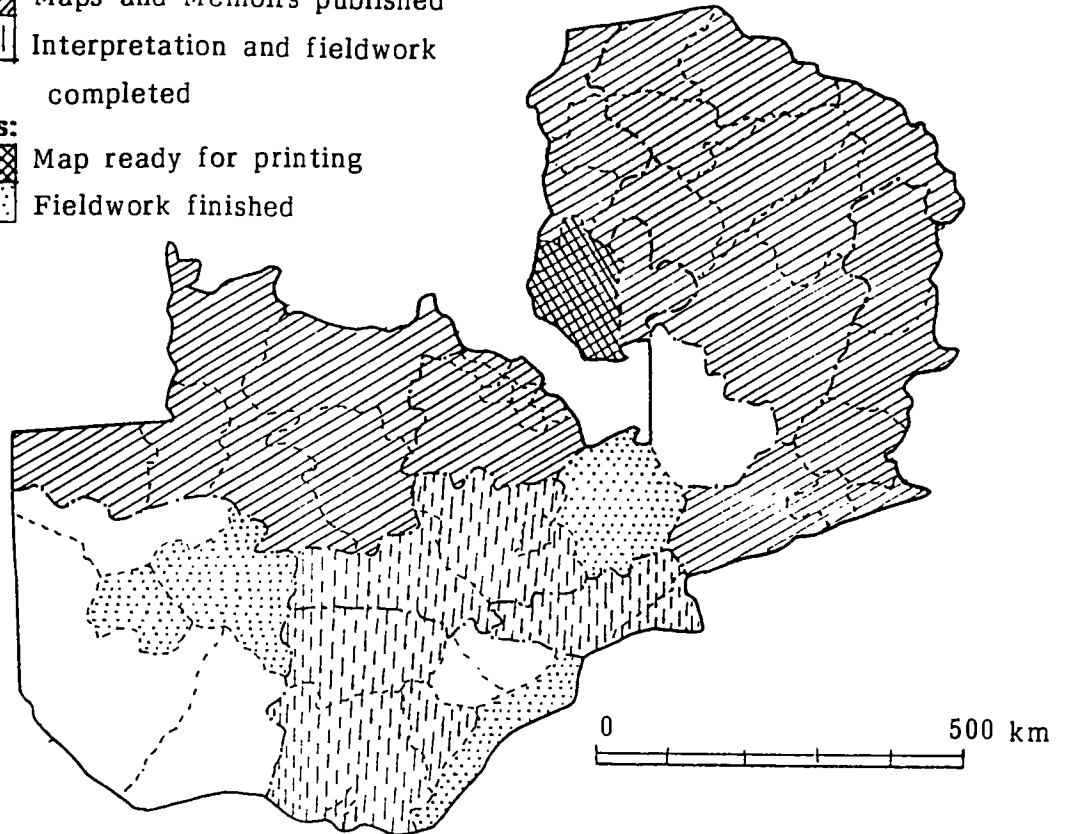
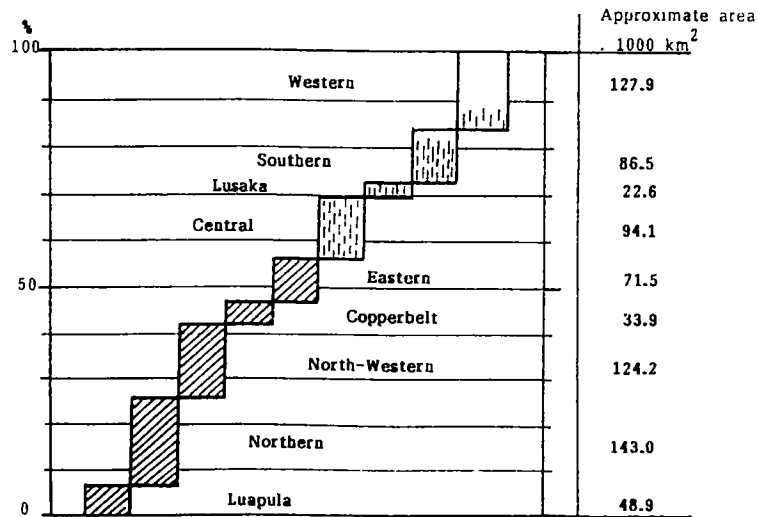


Fig. 2. The Republic of Zambia, with Provincial and District boundaries.

Progress of the mapping programmes



Oblique hatching: Provincial Map, 1 : 1 mill. with memoir, completed by end Nov. 1989.
 Broken hatching: Interpretation and field-work completed by end Nov. 1989.
 Open : Remains to be done in 1990.

Fig 3. Cumulative area-diagramme for the nine Provinces in Zambia.

Progress of the mapping programmes.

For Southern Province, geometrically corrected imageries have been used, and the transfer of soil-scape information was done directly from the imageries to base maps in scale 1 : 500 000. This would have been a better procedure for all the soil maps. For Central and Eastern Province the 1 : 500 000 Draft Maps have been transferred to base-maps of the same scale, and then reduced

All three procedures yield Exploratory Maps of satisfactory accuracy.

1. 1. 2. District maps - 1 : 250 000

The location of the five Districts chosen for Reconnaissance soil mapping is shown on Fig. 2. The expected progress for the five District Soil Maps (District Soil Map), is shown above, Fig. 1, and on Fig. 2.

The MANSA map should have been finished by the beginning of October 89. The "proof" of the final map was done on the 6th December, and it would have been possible to print the map in 1989.

The consultancy on printing will suggest further action (Lie & Sørensen 1990).

The accompanying report is word-processed, but editing remains. I have not seen the draft report, although it would have been interesting to have a look at the content.

According to Hesjedal, the next District Soil Map to be ready should have been GWEMBE. Due to difficulties with the base map (s), the map production has been delayed. The Cartographic Section at Survey Department insists on two base maps because the Gwembe District covers 5 separate map-sheets, see Hesjedal (1989, Appendix p. 62). This cannot be accepted, and I have given detailed instructions on how to solve this problem.

Because of these difficulties, the map which seem to be next in line is MKUSHI. The draft map will be ready in 1989, and this is earlier than expected. . All the other maps and reports are expected to be finished by July 1990, see Chapter 4. However, the drafts for the MONGU map and report were taken to Holland by J. Broekhuis for completion. This material has not yet been returned, and the actual finishing date for Mongu District Soil Map is pending.

If Mr. Broekhuis does not answer to written requests before the end of January 1990, direct contact must be taken for instance by telephone or telex.

Some of the maps within the District soil mapping programme is delayed, and others are ahead of schedule. The overall result is approximately as shown by Hesjedal. However, the word-processing of the reports do not follow the expected progress. This will be discussed in Chapter 3.

Map Legend

The map unit legend for Mansa District Reconnaissance Soil Survey (Chileshe 1987), is very brief.

The soil information is to the point, but nothing more. The soil classification is based exclusively on U S Soil Taxonomy !

The "first entry" to the legend should be physiography. Parent material could be mentioned if it has some clear impact on soil properties.

I would have preferred an "Extended Legend" in table form, as for instance in the report by Grimstad, Løyland, and Stuhaug (1985), see Appendix III. This table was set up in close cooperation with O. Spaargaren, Soil Correlator at that time.

The legend on a reconnaissance soil map must be as informative as possible, i.e. "User oriented". The present Soil Correlator and the Senior Soil Surveyor must sit down and work out a more comprehensive legend - *on the map*. In this context, it is important to define the potential users.

Both map legend and memoir content should possibly be discussed by a larger audience, because *the District Soil Mapping programme can be the most important "product" from SSU* in the near future (when the National Soil Map has been published). In this context the revised Land Evaluation system must become functional, and the presentation of "thematic maps" must be clarified.

Digitizing

The District Soil Maps should in my opinion be digitized first. The need for combining data towards a Land Evaluation system could be developed and refined for the printing of the five district soil maps. Later, when the system has been thoroughly tested, digitizing all Soil Survey maps should be routine.

As to date the digitizing of the five district maps has not started at all ! This is apparently a problem (bottle-neck), and I suggest that the computer consultancy should look into this.

In Chapter 3 and in section 2. 1. 4 , I have made some general comments about digitizing the different soil maps.

1. 1. 3. The "backlog" of Soil Survey Reports and Maps

The reported "backlog" on the production of the standard Soil Survey Reports, and Maps, has been a bad blemish on the SSUs reputation.

A re-evaluation of the "backlog" list shows that maybe as many as 14 reports and maps have been taken abroad for completion -, *or they have never been produced - except for the title !*. Five - seven titles cannot be published because the draft reports are incomplete (essential data are lacking), maps are lacking, or the hand written drafts cannot be understood. A number of reports have been finished during this year. Therefore, the present so called "backlog" is less than half of what was reported by Hesjedal (1989). The Soil Correlator Mr. N. Mukanda will produce a revised list of the present situation for the Soil Survey Reports. I hoped this list could be attached to my report, as an appendix. I am awaiting postal delivery from Zambia.

As with the District Soil Map, word-processing seems to be a bottle-neck, see Chapter 3.

2. The National Soil Map - 1 : 1 mill

2. 1 The present state of the Production Line

All information given about the Provincial mapping programme are directly relevant to the production of the National Soil Map of Zambia, scale 1 : 1 mill. , as described above.

According to Hesjedal (1989), the interpretation and mapping phase for the National Soil Map was behind schedule in February 1989, and only 40 % of Zambia was mapped. By the end of November the same year, only 14 % remains to be mapped, (and the last figure is well documented). I think this progress is remarkable.

The actual work on the National Soil Map is expected to start in 1990 (Hesjedal 1989, p. 14), and the interpretation and field work should be completed by the end of April 1991. This plan must be changed if the map and the accompanying report shall be ready for publication at the end of 1991.

In accordance with my TOR, I will discuss all the main steps in the production line; Present the major constraints (as they appear to me at present), give suggestions on how to eliminate "bottle-necks" (this includes the question of external help), and set up detailed work-plans for the whole production line.

2. 1. 1 Base Maps

In Appendix 4 (Hesjedal 1989, p. 59) detailed instructions about the four "base maps" for National Soil Map were given to the Survey Department. Three of the base maps (*Kasama, Blantyre, and Lusaka*) were finished by the end of November 1989. The last one - *Livingstone* - will be ready in January 1990. The quality of the three base maps shown to me are good.

The final editing of the sheets for printing will be discussed in Appendix IV.

2. 1. 2. Transfer of soil data to the National Map

The first step involves boundary adjustments between the different provincial soil maps. This work has been started for the Luapula, Northern and Eastern Provinces. It is carried out by the Cart. Sect. LUB, and then approved by the National Mapper, Mr. L. Chileshe.

Secondly the soil information (polygon delineation) must be transferred to the National Soil Map base map. This process has already been started on the Kasama sheet, by Mr. G. Mambwe, Cart. Sect. LUB. When this is finished, the National Mapper will do the necessary adjustments (simplifications).

The most important adjustment will be to correlate similar soils which have been given different polygon coding in the different provinces. This problem will be further commented in section 2. 2, where the Legend is discussed.

2. 1. 3. Cartographic-, and repro-work

The Cartographic Section LUB shall prepare the final maps and additional figures for the ordinary Soil Survey Reports, the District Soil Maps, the Provincial Soil Maps, and the National Soil Map! In addition to this, there are other jobs for LUB, and the "normal" odd-jobs which are laid on all drawing offices. Thus, the cartographers are heavily loaded with work, particularly from the middle of 1990 up-to the end of 1991.

The basic work at the Cartographic Section, LUB, is simple drawing. Four persons can do this, and the work-capacity is good. However, when it comes to the preparation of maps for printing in colour, only one (or two) have training for this kind of work. Cartographer G. Mambwe is in charge of the District Soil Map production lines, in close cooperation with the Cartographic Section, Survey Department (SD).

Mr. Mambwe has set up the "flow-sheet" for the Mansa District map, and he has prepared the 23 different "peel-coats". Together with Mr. Kantumoya (SD), they have carried out the necessary photo-work, "screening", and made the final films for printing the proof plate.

The Mansa map is rather simple regarding soil information (polygon size and numbers), and in layout. The National Soil Map will consist of four sheets with considerably more soil information: Many colours, and shades of colour; a very large number of polygons; and a more sophisticated "layout".

The number of peel-coats for each sheet may be between 50 and 70 (depending on Legend construction). This implies a total number of peel-coats between 200 - 280 (or even more!).

In addition, it is expected that the Cartographic Sections at LUB and SD shall produce the remaining four District maps, and do the drawing for Soil Survey Reports -, both the "backlog" and the ones which are done on the yearly programme.

Nearly all the cartographic- and repro-work must be carried out in 1990 and the first half of 1991, if the whole mapping programme shall be finished at the end of 1991. This would have been an almost impossible job, even if only the National Soil Map should have been printed. With the present working situation, it is quite impossible !

As far as I can see, this is by far the most serious "bottle-neck" in the production lines. The Cartographic Section at LUB must be strengthened. I suggest that one experienced cartographer should be set on the National Soil Map. This person must be able to plan, and implement all steps in the cartographic production line (including the "peel-coat" work). He must work independently, so that Mr G. Mambwe can concentrate his work on the four remaining District maps, and the other regular work. This person is needed as soon as possible, and he must be with the Cartographic Section LUB for at least one year.

2. 1. 4. Digitizing / or not ?

In the Hesjedal Report it was assumed that all maps should be digitized before publishing (footnote 3 on page 14, Hesjedal 1989).

To day five Provincial, and one District soil maps could have been digitized . This have not been done, and I do not believe that this is detrimental to the project. On the contrary, I would like to see a well documented argumentation for the need of digitizing the maps, - before it is started. I can not see that such a discussion has taken place.

From the recent information I have got, the software for large digitizing programmes is not available (or the software must be modified). I have been told that a large enough digitizing table is available at Survey Department, so the work can be done in Zambia (this has not been confirmed). However, as mentioned above it is debatable whether digitized maps in all scales; 1 : 1 mill , 1 : 250 000, and down to 1 : 50 00 (or larger), are needed

The exploratory soil maps - scale 1 : 1 mill. are hardly "accurate" enough for proper use of the established Land Evaluation System. The District soil maps are in my opinion, the smallest map scale where digitizing for Land Evaluation purposes are of direct agricultural interest, (see above, section 1. 1. 2).

The digitizing of the National Soil Map could, however, serve some purposes which are listed below:

1. If a national soil resource analysis is wanted, a statistical evaluation of all major soils in Zambia could be presented. Rough Land Suitability maps could be produced by a computer and printed in the scale wanted. All this could be valuable data for "National Development Plans.
2. Any changes to the National Soil Map in the future, could be easily done on the digitizing board.
3. Transfer of soil data to other organizations (UNEP, FAO, SADDC, and others) could be done by exchange of diskettes. The SOTER and GLASOD programmes would need digitized soil data, if they should be used in Zambia.

The possible digitizing of the National Soil Map should not be done before all soil data are transferred to the four map-sheets. It is previously stated that the main objective for the National Soil Map programme is National agricultural development planning. Such planning would require digitized maps. However, time does not allow this kind of work to be carried out until the National Soil Map and the memoir are published, i.e. after the out-phasing.

Priority should be given to the five District soil maps, and the Mansa map should be digitized as soon as possible. The computerized Land Evaluation (Crop Suitability) maps could be added to the report accompanying the map.

Finally, I recommend that the whole concept of digitizing is discussed thoroughly, and that this topic is taken up by the Information systems consultancy (by C. Hedberg).

2. 1. 5. Printing

The printing process is covered by another consultancy (T. Lie and P. Sørensen 1989). In their preliminary report (in Norwegian) they state that on certain conditions (of technical character), both the District - and the National Soil Map can be printed in Zambia by Government Printer. They also suggest that the Mansa District Soil Map should be used as printing-training in Norway, for two Zambian printers.

If this is accepted, an important question of timing will arise. When the two printers return from training, another map should be ready for printing, so that they can practise their newly acquired knowledge on the machines at Government Printer.

When Government Printer has completed the four remaining District maps, enough experience should have been accumulated for the most difficult task -, the printing of the four sheets of the National Soil Map

Data on map formats and suggestions for "map-sheet layout" for the National Soil Map is presented in Appendix IV.

2. 2. The Map Legend.

It has been decided to use the FAO-Unesco Legend for the National Soil Map of Zambia. Unfortunately, this legend has been under revision for the last decade. Drafts of the revised Legend have been published in 1983, 1985, and the "provisional edition of the final text" was published by FAO-Unesco (1988).

This revision has created problems for the National Mapper during his work with the legend for the National Soil Map of Zambia. In principle the 1988 version should be followed, but it should also be made allowance for some modifications.

So far, the work with the legend has been postponed due to lack of soil data from the whole country. However, if the National Soil Map shall be completed by the end of 1991, the National Legend must be set up in such a form that all Zambian soils can be fitted, - *without waiting for the mapping of the remaining 14 % of Zambia !*

The National Mapper and the Soil Correlator must make a decision as soon as possible. A Workshop on African Soils Correlation is announced for early 1990. Final decisions about Legend should be taken shortly afterwards.

The first entry to the Legend for the Provincial soil maps has been physiography, following the principles set up by Dalal-Clayton et al. (1985). *This must also be done for the National Legend.* If for instance geology (parent material) should have been used as a first entry, all the Provincial soil maps would have to be reconstructed.

The parent material can come in on a second level, or in the text of the report, but it should be mentioned. Geology has an important impact on soil development, particularly in the "low rainfall" areas of Zambia, as well as on the escarpments and in the rift valleys.

The most important feature in the Legend is of course the different soils. The major soil types will be separated as different colours, and I strongly advice the use of the same (or similar) colours as on the Soil Map of the World (FAO-Unesco 1971 / 73). The different Soil Units can be differentiated with shades of a certain colour, but the "third category" of classification must be presented in the map-polygon code.

A copy of the FAO-Unesco (1971) Legend (Sheet I), which include an "Analytical colour chart", is already ordered for Mr. G. Mambwe at the Cartographic Section, LUB, so that he can get acquainted with the colours used on the Soil Map of the World. The new soil types which have been introduced in the revised legend (FAO-Unesco 1988) must get appropriate colours. I will consult Dr. W. C. Sombroek at International Soil Reference Centre (ISRIC) about this.

After some discussions between the National Mapper and me in November, the work on the National Legend has been started. When a draft is ready, I would suggest that a Work-shop on the final Legend should be held, for ex. at UNZA, with an invited specialist as a consultant (Dr. Muchena - former Head of Kenya Soil Survey has been mentioned).

Either the draft, or the final product could be presented at the planned African Soils Correlation Meeting (in Nairobi - or elsewhere ?).

It is vital that the Legend should be thoroughly discussed. The final presentation must be informative, simple, and last but not least, with a readable coding.

More details, and suggestions for the National Legend are given in Appendix V.

2. 3. The Report accompanying the National Soil Map

The Report which shall accompany the National Soil Map should present the soil information from Zambia in a clear and readable form. There is a wide range of potential users, ranging from;

- a. Soils Scientists form all over the world.
- b. Decision-makers in Zambia who should be able to understand and use it for "National Development Plans".
- c. Students of Soil Science who want to learn more about the Soils of Zambia, and their potential use.

And surely many others.

This report should be written for a larger audience than the Provincial Memoirs, and I therefore suggest that it should be written in a more general form. So far the memoirs can serve as a good basis, but there will be need for correlating the different memoirs, and most of the local descriptions must be deleted.

An Editorial Committee should be established for the writing of the Report accompanying the National Soil Map of Zambia. They should elect an Editor in Chief. When the draft is ready, copies should be distributed to pre-selected referees for constructive criticism and comments.

The Land Evaluation part of the report will be important. (Cf. the Soil Map of Kenya; Sombroek et al. 1982). This topic must be discussed thoroughly by the Editorial Committee, and the digitizing question must also be considered. Decisions about the presentation of Crop Suitability maps and other thematic maps, must be taken soon. Additional maps in the National memoir (see Appendix VI), may create more work for the Cartographic Section and could cause constraints in the production lines.

An outline for a draft of such a memoir is presented in Appendix VI.

3. Possible constraints in the production lines

3.1 The Western Province Soil Map, 1 : 1 mill.

If the revised work-plan (Hesjedal 1989) for Western Province should have been followed, a bottle-neck would have been created. A solution of this possible constraint has been suggested by setting up a "forced work-plan" for Western Province, see Chapter 4. 2. This has been done in full agreement with the National Mapper, Mr. Chileshe. By this new plan the soil data will be transferred to the National Soil Map at the end of September 1990, - more than a half year earlier than the previous plan.

We think this is quite possible, when considering all the previous work carried out in the province. First of all, two districts are recently covered by reconnaissance soil maps (Mongu and Kaoma). This amounts to approximately 1/3 of the province. The classification of the soils in these two districts in accordance with the FAO-Unesco Legend should be easy.

Secondly, Brammer (1973) have published a preliminary soil map with a FAO-Unesco legend. A large number of soil profiles from Western Province (op.cit.) can be re-examined and give valuable information for the new provincial soil map. However, I would set a question-mark with the podzols mapped on the border to North-Western Province by Brammer (1973). These are classified as gleyic, ferralic (or albic) Arenosols by Wen Ting-tiang (1987). As a whole, there should be no large surprises regarding the soil distribution in Western Province.

I am therefore convinced that the newly revised work-plan can be followed. However, the progress of the new work-plan should be followed closely. Otherwise the completion of the Western Province soil map may develop into a serious bottle-neck.

3.2. Lack of qualified personnel

This is put up as a key point in the TOR for this consultancy. Hesjedal (1989) concluded that: "The backlog in the work of the National Soil Map of Zambia will require that external assistance be given to the National Mapper - who is also the Acting Senior Soil Surveyor. . . . , preferably for 2 years".

It is true that too much work has been laid on the shoulders of the National Mapper, Mr. L. Chileshe. However, I cannot see that there is any serious backlog regarding the interpretation, field-mapping, and preparation of draft soil maps for the National Soil Map up-to now. (A possible constraint is discussed above). With the return from studies abroad of Soil Surveyor Mr. Mulenga, the need for "expert" help on the soil sector will be unnecessary. Mr. Mulenga will work on the completion of Lusaka Province soil map, and thereafter be fully engaged on the National Soil Map. (Chileshe, pers. com.). In addition to this, the Soil Correlator, Mr. N. Mukanda has got relief on both the District-, and the Provincial level with the return of Mr. R. Msoni, who will work as Assistant Soil Correlator. As a whole, the SSU has been considerably strengthened this fall.

The real need for qualified help lies on the cartographic side. As stated above in section 2. 1. 3, the immediate need for help in the Cartographic Section, LUB, **must** be solved! Otherwise it will not be possible to finish the National Soil Map programme within the given time.

I believe that qualified cartographers can be found in Zambia, either in the state or the private sector. Advertising for such a person must be started as soon as possible. If it should prove difficult to find a cartographer in Zambia, a "head-hunting" mission in the neighbouring countries must be arranged.

Another (but smaller) bottle-neck related to qualified personnel is found on the typing / word processing side. To day only one typist, Mrs. F. Malemeno (called Mutemeno in Hesjedals report), is engaged. With the large number of Soil Survey Reports (> 15 ?), District reports (2), Provincial reports (4), and the National Soil Map - draft memoir to be completed in 1990, a large amount of work on word-processing will pile up. A short time engagement of a competent typist is suggested. A detailed list of word-processing work should be set up, and then the actual need of assistance can be evaluated.

3. 3. Lack, or shortage of equipment and materials

It was not clear whether all the necessary materials for "peel-coat" preparation was available, or not. In any case, the ordering and supply of such materials can easily be solved by setting up a stock-book which should be updated at regular intervals.

The consultancy on printing (Lie & Sørensen) suggests some technical improvements on the production of map proofs (responsibility of Cartographic Section, Survey Department). This is very important when it comes to the production of proofs for the National Soil Map. A large number of shades of colours, and many small polygons, will necessitate the production of the best possible proofs. Otherwise the actual proof-reading will be an extremely tough job. Even under the best conditions, this is a difficult and time-consuming task.

The handling of all peel-coats for the National Soil Map, and the five District Soil Map will be cumbersome without a proper archive system. Either a new "hanging-map" archive has to be purchased, or one of the available ones must be cleared.

It was also noted during the visit to the Cartographic Section, LUB, that the four sets of rulers on the newly ordered drawing-equipment was missing (by mistake they were not ordered at all !). Such details may influence the production lines in a negative way. The Project Coordinator must look into such possible constraints, by requiring check-lists from all parties concerned at regular intervals.

I would also recommend that the National Mapper and his co-worker should have a PC installed for the drafting of the National Legend and the Report, - *or this should at least be discussed*. I am sure that an increase in efficiency would be the result. Any increase in efficiency must be welcomed if the time-schedules shall be kept, - the margins are small !

Materials and equipment for the printing are covered by the consultancy report from Lie & Sørensen.

3. 4. Working conditions

This cannot be considered as a serious constraint, but I want to mention it because small details such as a good office chair, may raise the effectiveness of the personnel on the production lines. With the memory of the GRZ- office chair I happened to occupy at Mt. Makulu, I would recommend the purchase of some chairs with adjustable seat-height and back support. This is most important for those who work at the computers, and the drawing-tables.

In the drawing-office at LUB, the light conditions and the general environment seems very good, but in many offices the light conditions were not so good, and could easily be improved with small investments. All these recommendations must be a matter of economic priorities, - a point that I will not take up.

3. 5 Work routines

This is basically a question of communication, and will therefore be the responsibility of the Project Coordinator. However, I would like to mention the fine cooperation between the Cartographic Sections at LUB, and the Survey Department. To keep this up, and to improve on other parts of the production lines, I would recommend that fairly regular meetings between the parties concerned are held. Such meetings (for instance once a month), should evaluate progress and look for possible constraints at all stages in the production lines.

A more simple approach could be that the Project Coordinator in his function as a liaison officer solve problems as they appear.

3. 6 Printing of District- and National Soil Maps

After my TOR was written the consultancy on printing has been effectuated (Lie & Sørensen 1990).

I feel that the constraints which may arise during the printing of the maps is no longer my responsibility, except for the points which already have been made (see above), and some others that will be mentioned in Chapter 4.

4. Work-plans for the remaining period - 1990 and 1991.

The work-plans are set up as time-diagrammes, but with some more detail than the one presented by Hesjedal (1989, p.14).

4.1 The District Soil mapping programme

The time-schedule diagram (Fig. 5) has been set up in cooperation with the Soil Correlator, Mr. N. Mukanda, because he is directly responsible to the Acting Senior Soil Surveyor, for the District soil mapping programme.

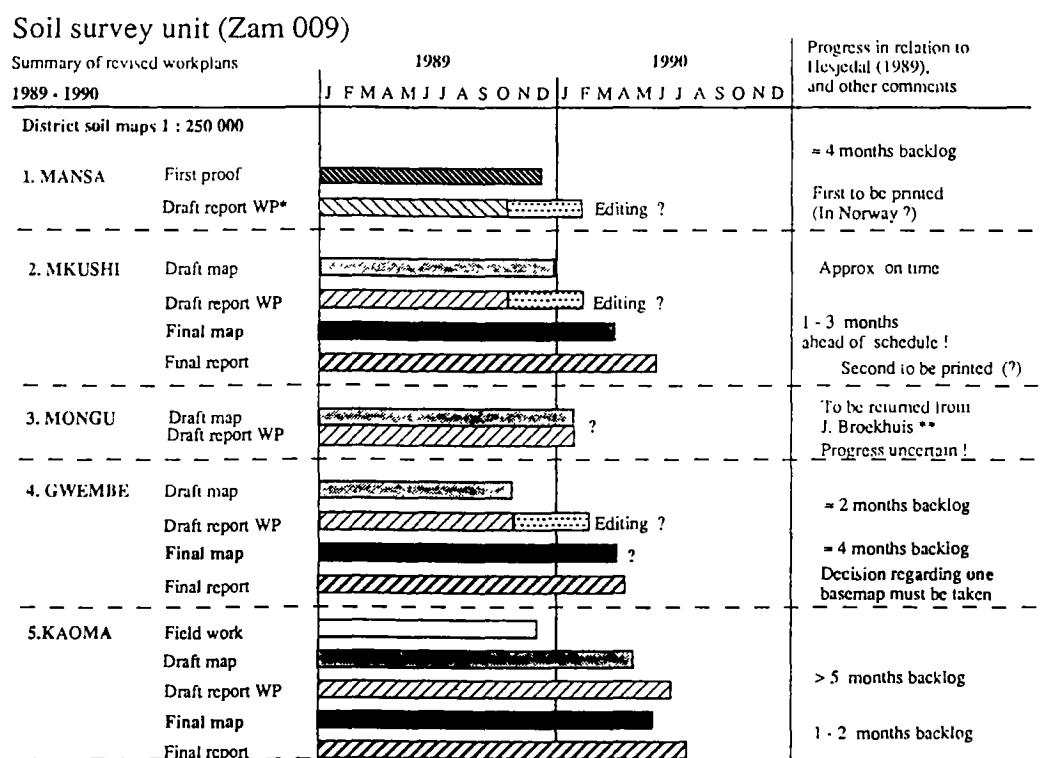


Fig. 5 Expected progress for the District Soil Mapping Programme.

* WP = Word-processing

** See point 3, next page.

The most important features of this diagram are:

1. The final maps for both MKUSHI and GWEMBE can be ready at approximately the same time (March / April 1990). A decision must be taken soon about which one shall be next in line for final printing. The Cartographic Section at LUB must be informed, so that work-plans can be set up. (Cf. the printing consultancy report).

2. Three word-processed draft report are at the same stage of development (Mansa, Mkushi, and Gwembe). I suggest that the final work on these reports are postponed until the discussion on digitizing has been completed. Digitized "thematic maps" could then be included in the reports, and surely make the reports more user-oriented.

3. The future progress of the MONGU District soil map is uncertain. If the material (draft map, and word-processed report) are returned in the beginning of 1990, the Cartographic Section will receive four (4) maps for final drawing at approximately the same time (March to May 1990). Priorities and detailed work-plans must be discussed with Mr. Chakwira and Mr. Mambwe ! Already at this stage, the need for extra help at the Cartographic Section must be considered.

4. 2 The Provincial Soil mapping programme

The revised work-plans for the four remaining provinces (Fig. 6), have been discussed with the Acting Senior Soil Surveyor, Mr. L. Chileshe, and the Soil Surveyors: Mr. Mulenga (Lusaka Province), and Mr. Mbinji (Southern Province). The special programme for Western Province was set up in agreement with Mr. Chileshe.

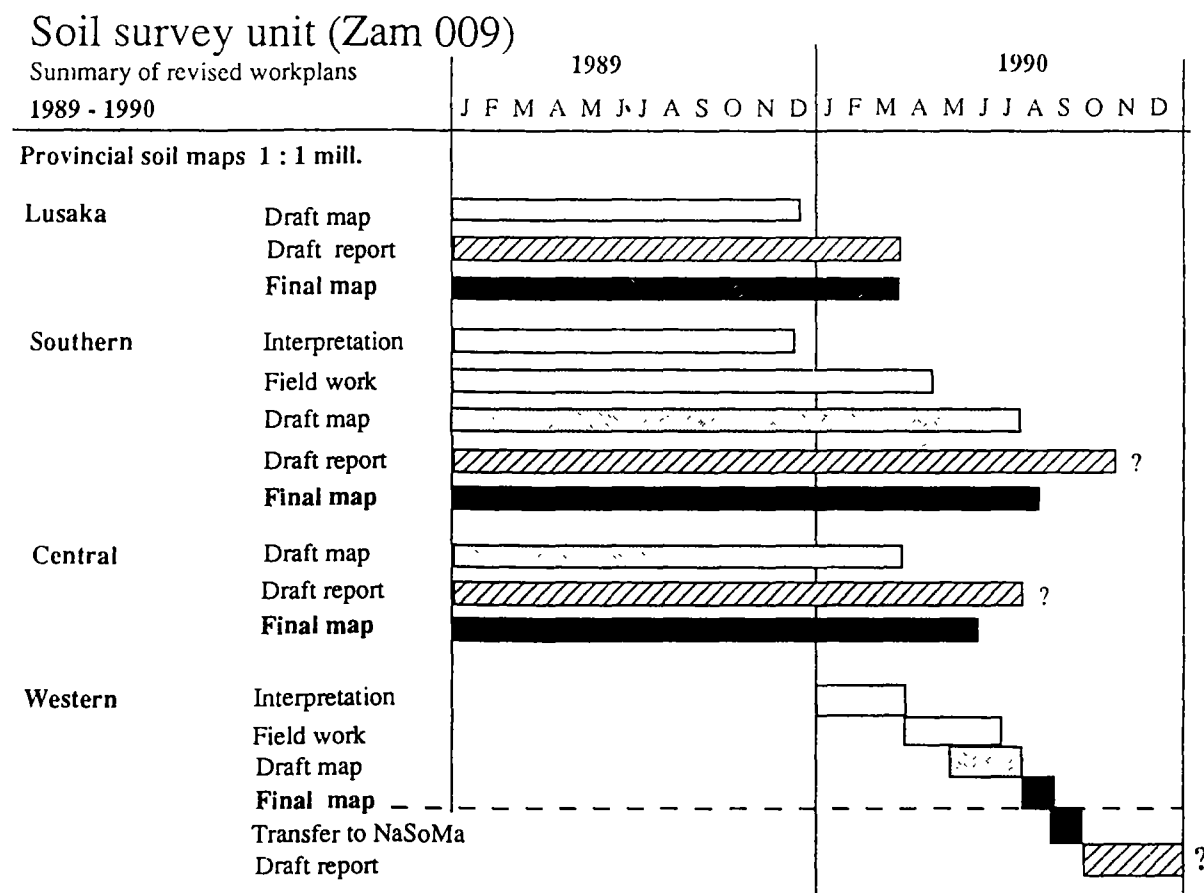


Fig. 6 Expected progress for the Provincial Soil Mapping Programme.

The most important features of this diagram (Fig.6) are:

1. The draft maps will be ready for final drawing in January (Lusaka), April - May (Central), and in July 1990 (Southern). This drawing programme must be presented for the Cartographic Section, LUB. There will be collisions with the drawing programme for District soil maps ! From my point of view the Provincial soil maps should be given priority, because they are the basis for the completion of the National Soil Map. However, these problems must be discussed jointly between SSU and LUB, to avoid misunderstandings and bottle-necks.

2. In the diagram all four draft reports have been given a final date, but I have not set up a precise date for the final report (Memoir). The reason for this is that the reports must be given lower priority than the maps at this stage. The maps **must** be finished if the National Soil Map shall be completed, whereas the reports can be edited when the worst rush is over. However, the word-processing of the four memoirs must be set up in the typists work programme for 1990 (early 1991 for Western Province ?).

3. Except for obtaining the satellite imageries, little has been done on Western Province (see section 3. 1). For that reason, a "separated" work-plan has been constructed. This is a rather tight schedule, but the transfer of soil data to the National Soil Map must have taken place at the end of September 1990, otherwise the completion of the main task within the given time limits, will be very difficult.

4.3 The National Soil Map

In Fig. 7 the production line for the National Soil Map has been separated into 12 different steps, which again can be divided into three main phases:

- The initial cartographic- and repro-work (1 - 7).
- The "proofs" phase (8 - 10).
- The printing phase (11 & 12).

The effect of the other mapping programmes on this time-schedule has not been taken into account !

Each "box" in the diagram indicate *a time interval* for each job, not that all the time is necessary for the completion of the job.

A written presentation together with Fig.7 was given to the Cartographic Sections at LUB and SD the last week I stayed in Lusaka. This written part is attached as Appendix VIII.

Soil survey unit (Zam 009)

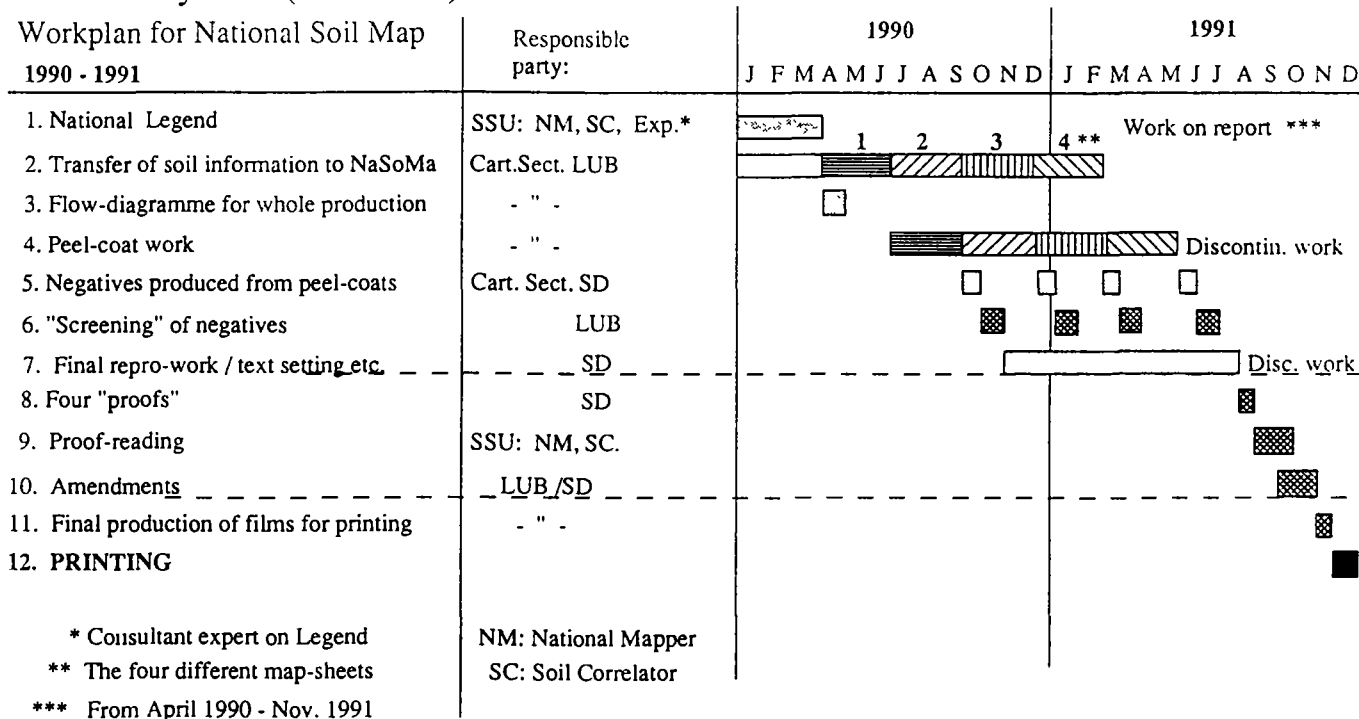


Fig. 7 Expected progress for the National Soil Map production, separated into 12 different steps.

Map-sheet 1; Kasama, 2; Blantyre, 3; Lusaka, and 4; Livingstone

The most important features of this diagram (Fig. 7) are:

1. The final National Legend must have been established during the first part of 1990 (by April). Only then will it be possible to do the final adjustments and simplifications on the draft map of each National Soil Map-sheets, see also section 2.1.2. These adjustments are included in bar no. 2, and the responsible party is SSU (not only Cartographic Section, LUB, as stated in the diagram).

2. The KASAMA (No. 1) map-sheet can be started as soon as the National Legend is decided. The main part of the BLANTYRE (No. 2) map-sheet can also be done early, but the Central Province soil map must be finished before Blantyre can be fully completed. The LUSAKA (No. 3), and LIVINGSTONE (No. 4) map-sheets can not be completed before the Western Province soil map is finished (September 1990). This must be remembered when the cartographic work on Lusaka and Livingstone is planned.

3. Step no.3 in the diagram refers to the kind of "flow-sheet" made for the Reconnaissance Soil Map of Mansa District, by Mr. G. Mambwe. This flow-sheet was positively commented upon by the printing consultancy (pers. com. Lie & Sørensen). Similar diagrams for the four National Soil Map-sheets will be considerably more complicated.

4. The actual work-input for each of the map-sheets has been estimated to 3 - 4 weeks (70 peel-coats). On Fig. 7, - bar 4, each map-sheet has been given three months for completion. I hope this is good enough margin, because the Cartographic Section, LUB, will have other tasks related to the National Soil Map, going simultaneously with the peel-coat work, (in addition to the other programmes!).

5. The steps 5, 6, and 7 will be done in close cooperation between LUB and SD. This requires good planning, so that it can easily fit into the ordinary work at both places.

6. The "proofs" phase has been given three months total time. This might look superfluous, but it must be taken into consideration that it might be necessary to make a "second proof" of the four sheets. Then the time will be needed!

7. As far as I understand, the consultancy on printing (Lie & Sørensen 1990) will discuss the production of films for printing, the production of printing plates, and of course the actual printing. According to Lie (pers. com.) the two last months of 1991 should give more than sufficient time for these steps. However, I am convinced that good margins on each step in the production line is required, - to make up for unexpected events.

The presentation of this diagram is also the conclusion of the consultancy: It will be possible to complete the National Soil Map of Zambia at the end of 1991! -

(Under certain conditions given above, and summarized in the recommendations).

5. Concluding remarks

5. 1. One obvious condition for success is that the time estimates / work-plans are correct. They have been set up in cooperation with staff both at SSU, and the two Cartographic Sections at Mulungushi House. We have tried to build in "safety margins" for the different steps in the production lines. However, some of the time-schedules set up by Hesjedal have not been followed, and that is only over a period of eight months.
 5. 2. In any organization where parts of the economic support are failing, the staff will feel insecure, they may lose interest, or start to look for other jobs. This problem has been mentioned by Hedberg (1989), and it is still of importance for the expected progress of all the SSU programmes. I have no suggestions how to solve this problem, but it should not be overlooked. In this context it is assumed that all key personnel at the production lines, stays with the project up to the end of 1991. My conclusions and recommendations are based on this.
 5. 3. It is also assumed that no unexpected events, like sickness or other reasons for leave of absence will occur among the staff. Some of the revised work-plans will create stress, which again can reduce efficiency.
 5. 4. The work of the Project Coordinator will be imperative for the implementation of all the different parts of the production lines, both for the District - and the National Soil Map, as well as for the "backlog" in Soil Survey Reports. Many people have been working well together up to now. In the process of finalizing the five District Soil Maps, and the National Soil Map, coordination is a key word if the tight time-schedules shall be followed. The communication lines must therefore be held open at all times, so that possible bottlenecks can be eliminated immediately. A person standing "besides" the production lines should also have the ability to foresee the unexpected. I can only support the decision already taken, that a Project Coordinator is attached to Zam-009.
 5. 5. The whole production of District Soil Maps, including printing, must be regarded as necessary training for the far more complicated National Soil Map production. If the preparation for printing and the actual printing of the District Soil Maps goes well, then - and only then, can one say that it is feasible to complete the National Soil Map of a required quality.
- A final comment:* So far there have been good progress in the production of the Provincial Maps - scale 1 : 1 mill, which are the basic input for the production of the National Soil Map of Zambia. Credit for this progress must be given to Acting Senior Soil Surveyor and National Mapper, L. Chileshe for his ability to produce results by being an effective and able leader of the project.

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VII. Revised list of "backlog" on Soil Survey reports, by: N.Mukanda. Not received by 30. January 1990.	
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TERMS OF REFERENCE**NATIONAL MAP CONSULTANCY****SOIL SURVEY UNIT (SSU) ZAM 009****1. Background**

The compilation and publication of a National Soil Map of Zambia (1:1 m) was started in 1982. To date about 60% of this task has been completed. According to the Revised Workplan, Hesjedal 1989, some external assistance might be required to speed up its production.

2. Objective

- To review and assess the state of the National Map Program and feasibility to complete this by 1991.
- To assess the need for external assistance as recommended by the Hesjedal Report, 1989.
- To draw up detailed plans for the successful publication by 1991 of the National Map and report.

3. Scope of Work

The work of the Consultant shall comprise, but not necessarily be limited to, the following tasks.

- Review progress to date as stipulated in the Revised Workplan, Hesjedal, 1989.
- Indicate draw-backs/bottlenecks and ways and means to eliminate these so targets can be met.
- If deemed necessary, draw up detailed workplans, including possible external assistance, to complete the compilation and publication of the National Map and report by 1991.

4. Modus Operandi

- The assignment shall be carried out within a 3-week period and will include a visit to Zambia (Nov/Dec) 1989.
- The consultancy shall be carried out in close cooperation with the appropriate Zambian authorities (SSU staff, Survey Dept, Cartographic Section, MACO) and NORAGRIC/NORAD.
- A summary of recommendations shall be discussed with the relevant authorities in Zambia before departure.
- A report, written in English, shall be presented NORAGRIC/NORAD, Oslo within 3 weeks of the Consultant's return.

NOR330

NORWEGIAN CENTRE FOR INTERNATIONAL AGRICULTURAL DEVELOPMENT
 AGRICULTURAL UNIVERSITY OF NORWAY

Rolf Sørensen
 Inst. for jordfag
 Postboks 28
 1432 ÅS-NLH

Your ref.:

Our ref.: 551/1008/89 JKrØ/AR

Date: 6. november 1989

KONSULENTOPPDRAK, ZAM 009

Det vises til vedlagte Terms of Reference.

Under forutsetning av instituttets godkjennelse gjøres følgende betingelser gjeldende for din medvirkning:

1. Oppdraget omfatter de oppgaver som er beskrevet i Terms of Reference.

Oppdraget innbefatter forberedelse før utreise, reise, utarbeidelse av rapport, som må foreligge seinest 2 uker etter avsluttet oppdrag. Feltarbeidet finner sted i perioden 18.11-08.12.89.

2. Vi forutsetter at du får permisjon fra din arbeidsgiver, at du opprettholder lønn derfra i perioden og at arbeidsgiveren sender refusjonskrav til NORAGRIC på faktisk lønn og sosiale utgifter.

Godtgjørelsen skjer med utgangspunkt i følgende timepris:

Årslønn l.tr. 31: kr 236.542 = kr 129,60
 Årstimetall 1840 t

I tillegg utbetaler vi feltgodtgjørelse på kr 312,- pr. døgn, som omregnes på timebasis.

Det skal føres timelister som leveres NORAGRIC etter avsluttet oppdrag.

Arbeidstiden i Zambia fastsettes til 42 t pr. uke i 3 uker. Det betales ikke overtid. I tillegg godtgjøres 7 t for flyreisen, tilsammen 14 timer. Totalt utgjør dette 140 timer.

3. Reisen foretas på de betingelser som fremgår av Regulativ for reiser i utlandet. Utgiftene dekkes av NORAGRIC i

overensstemmelse med dette og på grunnlag av innsendt reiseregning, reiseplan, originale billettalonger og originalbilag. Ved manglende originaldokumentasjon kan refusjon ikke påregnes. Skulle regulativets sats for godtgjørelse og natt-tillegg endres opp eller ned i løpet av reisesens varighet, vil den til enhver tid gjeldende sats bli benyttet. Vedlagt følger avtrykk av regulativet samt reiseregningsskjemaer. Reiseregning må leveres seinest 2 uker etter avsluttet feltbesøk. Regulativet utgjør en integrerende del av denne kontrakt, og bestemmelsene her forutsettes kjent. Du kan få utbetalt reiseforskudd.

4. NORAGRIC har en standard reiseforsikring, slik det går frem av vedlagte oppsett.
5. En orientering om AIDS av dr. Ivar Helle følger som vedlegg.

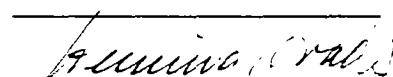
De bestemmelser som er gjengitt i vedlagte dokumentasjon, forutsetter vi som tilstrekkelige for oppdraget. Skulle det være spørsmål og uklarheter, ber vi om at du tar kontakt.

Vi foreslår at dette brevet med din undertegning gjelder som kontrakt.

Vi ønsker deg lykke til med oppdraget og håper at det blir en utfordring både for deg og NORAGRIC.

Med vennlig hilsen

Stein W. Bie
avd.direktør



Henning C. Svads

Vedlegg

Foranstående betingelser aksepteres:

..... *AS-NLH* den *8.!!* 1989
..... *Rolf Sorensen*

LIST OF MEETINGS during the visit to Zambia,

19. Nov. - 7. Dec. 1989.

- 19. 10** 09.00 Short meeting with Mr. S. T. Bakaas, Scan-African. Arrangements for transport.
- 11.00 Visit to Mt. Makulu - I was shown around by C. Lungu, the Land Evaluator and the Soil Chemist.
- 21. 10.** 07.45 Short meeting with S. Lundqvist to make appointment for next day. Met also O. Wennerby.
- 08.45 Short meeting with Thor Larsen at NORAD
- 14.00 Introduced to L. Chileshe, N. Mukanda, and R. Msoni.
- 22. 11.** 08.30 Meeting at Survey Department with S. Lundqvist, Chief Cartographer J. Musabula, and Senior Cartographer P. Kantumoyo.
- 10.30 Meeting at Land Use Branch with Senior Cartographer Chakwira, and Cartographer G. Mambwe.
- 14.00 Short talk with Thor Larsen, NORAD, Lusaka
- 23.11.** 09.00 Meeting with L. Chileshe, N. Mukanda, and R. Msoni. Status of the National Soil Map, District Soil Maps, and Soil Survey Reports & Maps. Explanation of "backlogs".
- 11.30 Short meeting with Mr. R. Raemaekers, Plant Pathology Section. Allowed to use Mackintosh for making notes.
- 24.11.** 10.00 Went to Government Printer together with Mr. J. Musabula (SD), for talks with Mr. Mwanza. Presentation of "problems" in the production lines for National - and District Soil Maps programme. Importance of printing within Zambia was stressed. Brief orientation about the printing consultancy. Made appointments for Lie & Sorensen.
- 14.00 Short discussion with Soil Correlator N. Mukanda on the District Map Programme.
- 25. 11.** 10.30 Brief talk with Soil Information Officer Chr. Lungu about word-processing. Orientation about hardware and software for Report writing and editing.
- 27. 11.** 08.00 Short visit to Senior Cartographer, Mr. P. Kantumoya for information about "base maps" for National Soil Map.
- 28. 11.** 10.00 Short discussion about District Soil Maps and Soil Survey Reports and Maps "backlog" with Chr. Lungu (word-processing) and Assistant Soil Correlator Mr. R. Msoni.
- 14.15 Met Mr. Mulenga who is responsible for Lusaka Province Soil Map - scale 1 :1 mill.

29. 11 09.00 Visit to UNZA-School of Agriculture / Soil Department. Half an hour talk with Dr. V.R.N. Chinene about Zambian soils, the need of a National Soil Map, Land Evaluation etc.
- 10.00 Visit to Geography Department. Met Mr. M. Mbinji. Made appointment with Chief Cartographer Mr. Banda, for discussion about the use of Satellite Imageries in Soil mapping.
30. 11 15.00 Brief meeting with Mr. Banda, Geography Dept. UNZA had no useful information about Sat. Imag.
- 15.45 Short talk with S. Lundqvist Survey Department. Delivered draft of Work-plan for Cartographic & reprographic work on National Soil Map. Expect comments from SD. staff.
02. 12 08.30 To Lusaka Airport - (BA-flight on schedule). Met Mr. T. Lie and Mr.P. Sorensen
04. 12 08.00 Working-breakfast at Inter-cont. Lie & Sorensen were briefed about the different Mapping programmes and their progress.
- 09.00 Met Mr. Commissaris at NORAD. The printers were introduced to T. Larsen.
- 10.00 Appointment at Government Printer (Mr. Mwanza sick), but we met Second in command, and were shown around the printing plant.
- 11.30 Lie & Sorensen were introduced to Chileshe and and Mulenga at Mt. Makulu.
- 05.12. 14.30 Meeting with the Soil Correlator, Mr. N. Mukanda: latest progress report on District Soil Maps, and the "backlog" in Soil Survey Reports and Maps. Revised priority list requested.
- 06.12. 0830 Short meeting with Cartographer G. Mambwe LUB about my proposed work-plan for National Soil Map. Unfortunately Mr. P. Kantumoya was not present. Proof-print of MANSA District Soil Map - scale 1 : 250 000 was demonstrated ! Paper copies of two base-maps for National Soil Map was obtained from LUB.
- 16.00 At Mt. Makulu; Final orientation about National Soil Map progress, the other mapping programmes, preliminary recommendations and conclusions. Comments from participants are noted down ! Farewell to SSU staff. Thanks for excellent cooperation.

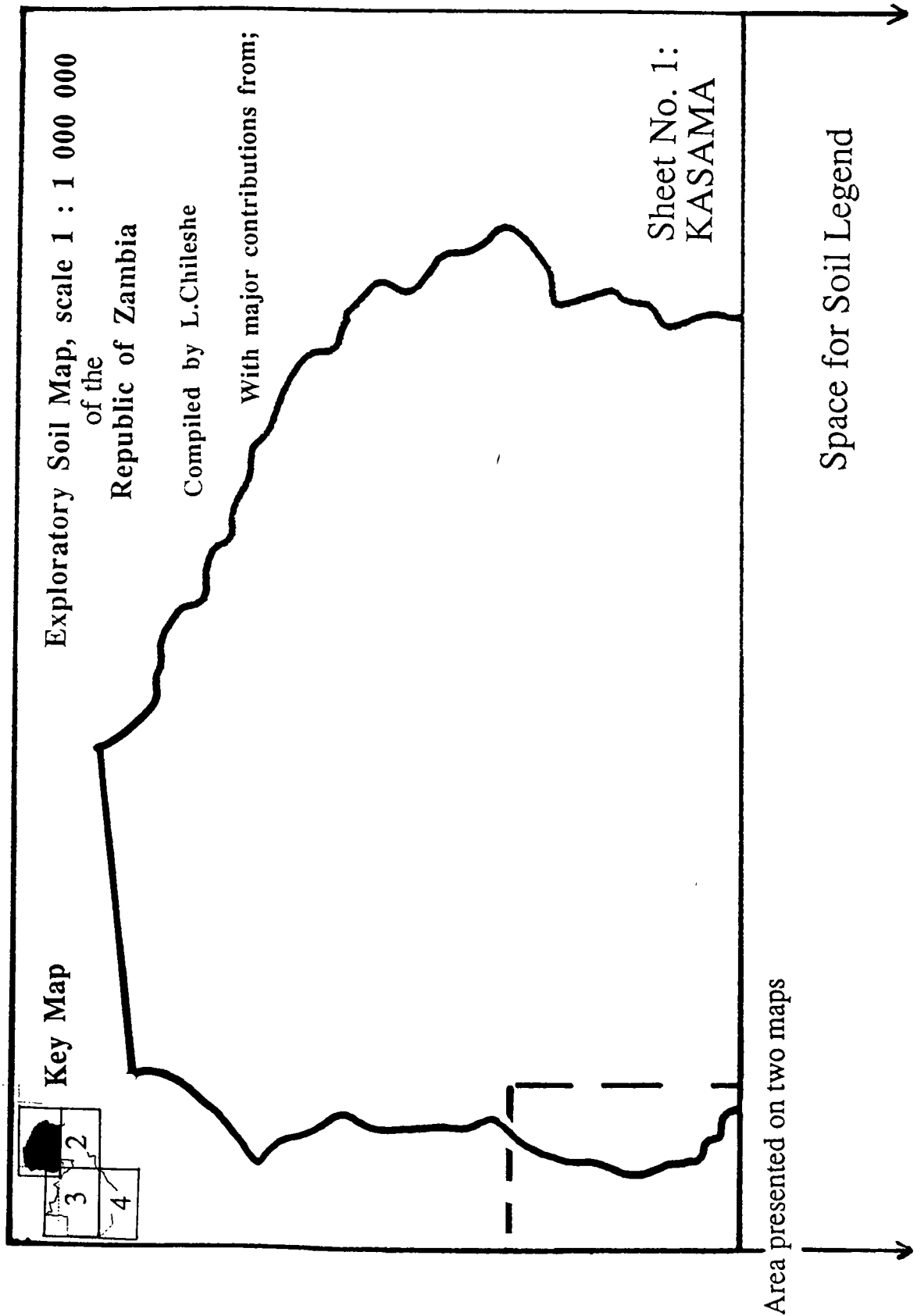
End of consultancy.

An example of "Extended Legend" for District Soil Maps.

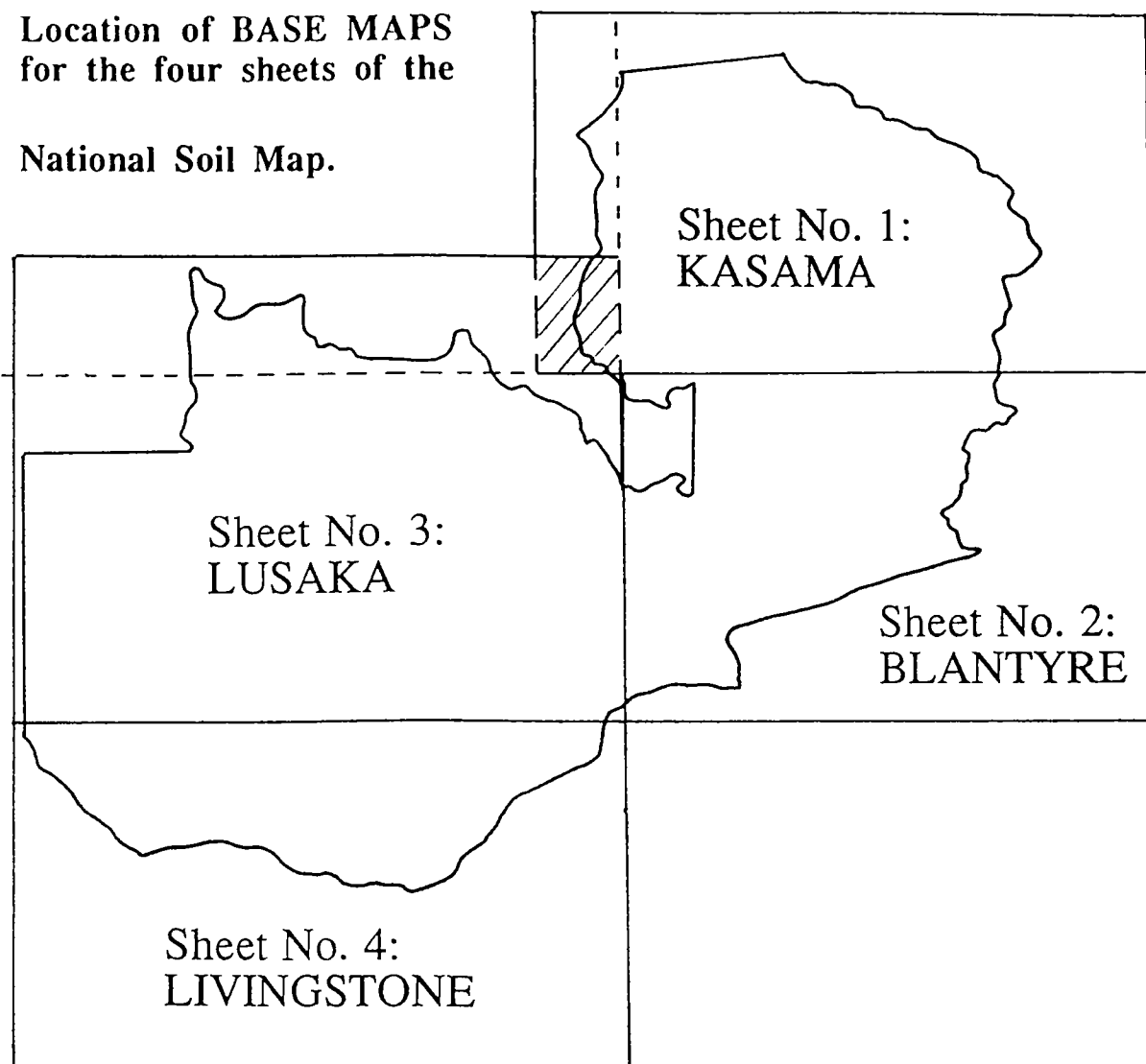
Mapping unit symbol	Description	Soil name Zambian Soil Classification (first approx.)	Soil Taxonomy (modified)*	Taxonomic Classification FAO-UNESCO	Area ha
cko	Deep, well drained, red clayey soils with sandy clay loam topsoils, strongly acid, very low nutrient reserves, very low nutrient holding capacity, medium organic matter content, weakly structured; on very gently sloping uplands.	Konkola sandy clay loam	Fine, mixed, isohyperthermic Typic Haplustox or Clayey, mixed, isohyperthermic Oxic Rhodic Paleustult	Rhodic Ferralsol, medium textured or Ferric Acrisol, medium textured	285 2.1
ckq	Deep, well drained, reddish yellow, clayey soils with sandy clay loam topsoils, slightly silty, strongly acid, very low to low nutrient reserves, low nutrient holding capacity, low organic matter content, weakly structured; on very gently to gently sloping uplands.	Kavambwa sandy clay loam	Clayey, mixed, isohyperthermic Oxic Paleustult	Ferric Acrisol, medium textured	3,528 26.0
ekq	Same, but with sandy clay topsoil.	Kavambwa sandy clay	- do -	Ferric Acrisol, fine textured	3,103 22.9
cmr	Deep, well drained, yellowish red to strong brown, clayey sometimes sandy clayey soils with sandy clay loam topsoils (very strongly acid, very low nutrient reserves, low to very low nutrient holding capacity, low organic matter content, weak to moderately structured; on very gently sloping uplands.	Mufulira sandy clay loam	Clayey, mixed (or mollic) isohyperthermic Oxic Paleustult	Ferric Acrisol, medium textured	1,608 11.9
emr	Same, but with sandy clay topsoil.	Mufulira sandy clay	- do -	Ferric Acrisol, fine textured	1,110 8.2
lcb-1	Association of deep, poorly drained, light gray to light brownish gray, fine loamy soils with dark coloured, thick loamy topsoils, strongly acid, very low nutrient reserves, high nutrient holding capacity, medium to high organic matter content; in seasonally waterlogged depressions; and deep, imperfectly, sometimes moderately well drained, pinkish gray to light gray fine loamy soils with sandy loam topsoils, strongly acid, low to very low nutrient holding capacity, low to very low organic matter content; on very gently to moderately sloping dambo fringes.	Association of Chambishi loam and Nampande sandy loam	Fine-loamy, siliceous, acid isohyperthermic Typic Hydrant or (Tropoli)luvent and fine-loamy, siliceous, isohyperthermic Ultic Haplustox	Humic Gleysol, medium textured and Xanthic Ferralsol, medium textured	1,211 8.0
lbe	Shallow to moderately deep, well to somewhat excessively drained, yellowish red, extremely gravelly fine-loamy soils with very gravelly sandy loam topsoils, strongly acid, low nutrient holding capacity, low to medium organic matter content, weakly structured, on some level to nearly level parts on the crest.	Safeti very gravelly sandy loam	Loamy-skeletal, siliceous, isohyperthermic Oxic Haplustult	Ferric Acrisol, medium textured, petric phase	48 0.3
xs1	Deep, well drained, reddish yellow, fine-loamy soils with loamy sand topsoils, strongly acid, very low to low nutrient reserves, low nutrient holding capacity, very low to low organic matter content, moderately structured; on very gently to gently sloping uplands.	Shilende loamy sand	Fine-loamy, siliceous, isohyperthermic Oxic Paleustult	Ferric Acrisol, coarse textured	947 7.0
S1	Same, but undifferentiated topsoil.	Shilende	- do -	- do -	1,521 11.2
mLu	Miscellaneous land unit comprising the escarpment area with many rock outcrops and ironstone gravel; gently sloping to moderately steep upland.	-	-	-	191 1.4
					13,552 100.0

From: GRIMSTAD, LØYLAND, and STUHAUG (1985).

Appendix IV. National Soil Map "layout" and dimensions



**Location of BASE MAPS
for the four sheets of the
National Soil Map.**



DIMENSIONS:

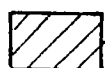
(total length and width of of the topographical sheet)

Sheet No. 1: KASAMA - 90 cm x 60 cm - c. 0.54 m²

Sheet No. 2: BLANTYRE - 75 cm x 60 cm - c. 0.45 m²

Sheet No. 3: LUSAKA - 80 cm x 75 cm - c. 0.60 m²

Sheet No. 4: LIVINGSTONE - 75 cm x 60 cm - c. 0.45 m²



Area presented on two maps (Kasama and Lusaka)

The Printing Press capacity allows for ample space for Soil Legend below each individual map sheet.

The numbering of the sheets are just a suggestion.

Appendix V

National Soil Map Legend - suggestions

It has been decided that the legend should be based on the FAO-Unesco Soil Map of the World system. The definitions of the major soil groups should follow the latest edition of the Revised Legend (FAO-Unesco 1988).

I also suggest that the colours on the National Soil Map should be as close as possible to those used on the Soil Map of the World. I have discussed this briefly with the Cartographer Mr. G.Mambwe, and I have also sent him a copy of the FAO-Unesco colour legend.

Major questions about the Legend for the National Soil Map are:

1. The physiography must be the first entry in the Legend, but shall physiography coding be included in the map-symbol? If not, can the FAO-Unesco presentation of landforms be used?
2. How shall the sub-units (third category classification) be presented on the soil map?
3. How shall "Soil Associations and Complexes" be presented on the map, and how shall the content of "inclusions" be presented?
4. The FAO-Unesco legend has three categories of soil texture in the map code (family criteria). Is it possible to adopt this kind of presentation also on the National Soil Map?
5. Will there be space for a soil description for each soil unit on the map legend, or should only the soil name be presented, and the full description given in the report?
6. Shall the legend be presented on all the four map-sheets? Shall the full legend be presented, or only those soil units which occur on the individual sheet?

In the following I will try to give answers to these questions. My answers must only be regarded as suggestions, open for discussion by the responsible person, or group of persons who must make the final decision. There will most certainly be other questions to be answered as the legend develops, and therefore I strongly suggest that a Work-shop on these questions should be held as soon as possible, see "Recommendations", page IV.

Approximately 17 "major soil groups" are present in Zambia (of a total of 28 in the revised legend). Within these 17 soil groups there are approximately 45 "soil units", and most of them are present on all the four map-sheets of the National Soil Map. If the third category; "soil sub-units" are included, there will most likely be about 80 soil types.

The Kenyan Soil Map Legend contains 102 soil types, including some "third category" soil units. When these are grouped according to physiography and geology, the Kenyan soil map ends up with approximately 400 different mapping units.

The distribution of soils in Zambia are not as complex as in Kenya, and a realistic number of soil types will be between 70 or 80.

With 17 soil groups there must be 17 distinct differently colours on the map. Some of the soil groups are related in nature, and it would be logic to use similar colours for such soils. For instance, shades of red, orange and rose could be used for Ferralsols, Acrisols and Lixisols.

This principle is used on the Soil Map of the World, and on most other soil maps.

The soil units (or types, including soil sub-units) will be presented as discernible shades of the base colour. This can be achieved with different types of screening, and is

basically a cartographic problem. However, the soil scientist and the cartographer must work in close cooperation during this phase of legend planning.

Physiography:

On the Provincial Soil Maps there are a separate physiographic legend with basic units like: Degraded plateau; Rift trough, Alluvial landscapes, and others. On the map each mapping unit have a double lettered physiographic code, for instance Pu - Gently undulating plateau, with dominant slope % : 1 - 3,.

The next information in the polygon code is the soil itself, for instance Gd / 2 = one sub-type of Gleysol called *fluvi-dystric Gleysol*.

If physiography should be left out of the code, and the FAO system adopted as an alternative, the code could be written: **Gdf 2a**. Gdf indicate a *fluvi-dystric Gleysol*, as above. The letter **a** indicate a level to gently undulating landscape, and the number **2** indicate medium textured soils.

This code is directly comparable to the Soil Map of the World, and I believe that it also is easier to read and understand. It should be quite possible to introduce more than three landscape codes, or re-define the FAO-Unesco slope classes. I don't believe it is necessary to use more than three textural classes (coarse, medium, and fine).

Soil sub-units:

The third category in FAO-Unesco classification has already been presented above. Many mapping units will only be classified to *soil unit* level, but where it is found necessary the *soil sub-unit* may well be introduced. However, I believe that all sub-units should have the same colour as the soil unit. The soil sub-unit will only become apparent in the third letter (Gdf).

If these changes are accepted, all the map-unit codes must be re-coded by the Soil Surveyor. But I suppose that the re-coding must be done in any case, when the different Provincial Soil Maps shall be correlated.

Soil Associations and Complexes:

On exploratory soil maps almost every mapping unit (polygon) is an association or a complex of soils. However, I accept the presentations on the Provincial Soil Maps. The map presentation can be done in three ways; With horizontal stripes (Associations), with vertical stripes (Complexes), and with alternating narrow and wider stripes (two variants of associations; Soil A is dominant over soil B, or the opposite).

Soil Description on Map Legend:

With the relatively large number of mapping units on each sheet of the National Soil Map, I believe that it will only be room for the soil name. A more detailed description of each unit will be given in the report in any case. It might be discussed if the equivalent name in US Soil Taxonomy should be included (in brackets) on the map legend. Again it is to some extent a matter of available space.

The legend on the individual sheets should present only the mapping units which are found on the map. Otherwise it may confuse the reader. With one standard legend on all four sheets, the cartographic work would have been rationalized.

Appendix VI.

National Soil Map - MEMOIR / REPORT content.

This memoir or report should be written for a larger audience than the Provincial Memoirs, and I therefore suggest that it should be written in a more general form. So far the memoirs can serve as a good basis, but there will be need for correlating the different memoirs, and most of the local descriptions must be deleted.

The Report accompanying the Exploratory Soil Map of Kenya (Sombroek et.al. 1982) could be used for comparison. This report contains 75 % text which explains the classification of soils, the complete legend, how to use the map and the report, and selected references. The remaining part of the report describes the Agro-climatic zonation in Kenya, and a few pages about Land Evaluation. Much information is presented in Tables. The potential readers of such a report are mentioned on page 11. Therefore the balance between Classification and Land Evaluation should come out in the favour of the first mentioned, but not more than 75 % as in the Kenyan report. Buol (1985) has very radical views on the ratio between "theoretical" versus "practical" presentation in a report. Although his ideas should be kept in mind, they are more applicable for District Soil Map Reports than for the present report.

In the Kenyan Report four maps (all in scale 1 : 1 mill) are presented (two in full colours); 1. The Exploratory Soil Map, 2. The Agro-climatological Zone Map, 3. The combination of the two afore-mentioned (in four colours: black, white, red, and blue), for Land Evaluation purposes, and 4. A map presenting the information base.

General "lay-out" of the memoir / report.

The introduction should contain a summary of the environmental factors (Climate, Geology, Topography, and Vegetation). The "Proceedings of the XI International Forum on Soil Taxonomy and Agrotechnology Transfer" held in Zambia in 1985, is a very good basis for this introductory chapter.

The reader must be informed about how the map has been produced, from the "interpretative phase" to the final compilation. The expected "accuracy" or "predictive value" of the map must be discussed. In the introduction to the Provincial Soil Map Memoirs it is stated: "For district planning purposes this map has limited utility, ". This is an understatement, and it may give a wrong impression of the actual use of an exploratory map, see page VII and VIII in the introduction to this report.

It is therefore important to present a map with an "Information Base" as in the Kenyan report. Such a map was enclosed in the SSU Evaluation Report of 1985. All reconnaissance surveys was plotted on a map in scale 1 : 2 mill. A similar updated map (even in smaller scale) must accompany the National Soil Map of Zambia Report. Only then can the reader evaluate to what extent the "accuracy" of the National Soil Map exceeds an exploratory soil map based on satellite imagery analysis. The construction of such a map can start immediately.

The "first entry" to the Legend in the Provincial Soil Maps has been physiography, and this must also be the case for The National Soil Map (see page 10). For this reason the description of "The physiography of Zambia" should be given some extra attention in the report. I would recommend that a Physiographic Map of Zambia, and / or Fig. 7 (Cross section of Zambia) in Dalal-Clayton et.al.(1985) should be presented in the report. A

good descriptive section about physiography could lead to a simplification of the Map Legend (see Appendix V).

A considerable part of the Kenyan Report (Sombroek et.al. 1982), is focused on the Agro-climatological zonation as a basis for Land Evaluation. Veldkamp (1987) has presented an Agro-ecological Map of Zambia. This map should be shown in the present report, and serve as basis for the discussion about Land Evaluation. It would be possible to combine the soil map and the agro-ecological map, as it is done in the Kenyan report. However, I believe that a much better product could be obtained if the National Soil Map of Zambia and the Agro-ecological Map were digitized. Then it would be possible to set up meaningful statistics about the Zambian Soil Resources, and also present thematic maps of several kinds. As stated elsewhere (page 9), I believe that time does not allow for the digitizing of the National Soil Map of Zambia within the present project period (before end of 1991).

As mentioned in the "Recommendations", an Editorial Committee should be established in the near future. This committee must discuss the points mentioned above, and any other opinion about the content of the report. A final decision about the content of the report must be taken before the end of 1990, because the Report / Memoir accompanying the Exploratory Soil Map of Zambia must be printed by the end of 1991. Therefore the drafting of the report should be started as soon as possible.

Future work on the National Soil Map of Zambia:

The complete analysis of the National Soil Map of Zambia (in digitized form), together with the Agro-ecological zonation, and other relevant data, could be a rewarding exercise and a basis for a new project, ending up with a fairly accurate evaluation of Zambias soil resources.

Appendix VIII

Recommendations Draft: 5. Des. 89. RS

The Mapping programmes:

Soil Survey Maps -1 : 50 000: These should be printed in black & white, with soil information on the ordinary topo. -sheet base. Then the LUB cartographic section could copy them as done before. The suggestion by Hesjedal to print topo. -information in colours seems superflous. This because the users of the maps will want colours for their additional information and coding (Planning etc.). The distribution will be delayed, and the cost will be higher.

The District Soil Maps - 1 : 250 000: The MANSA District Soil Map is ready for production of the first proof by mid December 1989.

Because of the planned training in Norway for Government Printer staff, an other District Soil Map should be ready for printing on their return. It is therefore very important that decisions are made soon, regarding the next District Soil Map which should be made ready for the repro-phase.

The Senior Soil Surveyor and the Soil Correlator must do this !

The National Soil Map of Zambia, 1 : 1 mill

A detailedd work-plan with "Flow diagramme" have been drafted. The draft has been discussed with Mr. M.H. Chakwira and Mr G. Mambwe at LUB, and Mr. J. Musabula and Mr. P. Kantumoyo at the Survey Department, - and agreed upon. (See Appendix IX).

Additional comments:

The work on the Legend for the National Soil Map has been started. When a draft is ready, I would suggest that a Work-shop on the final Legend should be held, for ex. at UNZA, with an invited specialist as a consultant (Dr. Muchena - former Head of Kenya Soil Survey has been mentioned).

Either the draft, or the final product could be presented at the planned African Soil Correlation Meeting (in Nairobi - or elsewhere ?).

It is vital the Legend should be as good as possible -; Informative, simple, and with a readable coding.

The Cartographic and reprographic Flow Diagramme for MANSA District Soil Map worked out by Mr. G. Mambwe is an excellent work-plan, and such Flow Diagrammes must also be made for the National Soil Maps.

However, it might be necessary to get expert advice or training, on the total Cartographic and Reprographic work-plan for the National Soil Map.

It may be beneficial for the final product, if expert advice were sought on the "Lay-out" of the four map-sheets for the National Soil Map. I will produce a list of what I think should be on the maps, but an expert Map Editor ought to be consulted. [This can be done in Norway].

One of the main constraints in the production line will in my opinion be the production of a large number of "peel-coats". I therefore suggest that the staff at Cartographic Section LUB, should be strengthened during the main phase of peel-coat work (see Flow sheet: From March 1990 to march 1991). The person should be able to work fairly independently on the actual peeling of sheets.

I would also suggest the purchase of a new arhive for the "peel-coats" for both the District-, and the National Soil Map. [There will be approximately a total of 125 peel-coats for the District Soil Map, and >200 for the National Soil Map].

The handling and storage of these shoul be organized in the best way.

The Report which shall accompany the National Soil Map should present the soil information from Zambia in a clear and readable form. The potential users of such a map will be quite varied, ranging from;

- a. Soils Scientists form all over the world.
- b. Decision-makers in Zambia who should be able to understand and use it for "National Development Plans".
- c. Students of Soil Science who want to learn more about the Soils of Zambia, and their potential use. - And possibly many others.

An Editorial Commitee should be established for the production of the Report accompanying the National Soil Map of Zambia. They should elect an Editor in Chief. When the draft is ready, copies should be distributed to preselected referees for constructive criticism and comments.

The Land Evaluation part of the report will be important. For an efficient use and presentation of all the soil data, the whole National Soil Map should be digitized in such a way that all soil units (polygons) can be located to Province and District, with their individual soil information. It must be possible to choose a certain soil type, to see the total distribution of this soil in Zambia, and to produce Crop Suitability maps for the whole country from the database.

UNEP and ISRIC have developed the SOTER database for such exploratory maps, and I suggest that a local variant of the SOTER should be developed for the National Soil Map of Zambia.

The digitizing programme should be part of the consultancy done by Calle Hedberg (Included in his TOR).

The printing of the National Soil Map will be looked into by another consultancy

The work of the **Project Coordinator** will be imperative for the imple-mentation of all the different parts of the production lines, both for the District - and the National Soil Map, as well as for the "backlog" in Soil Survey Reports.

Many people have been working well together upto now. In the process of finalizing the five District Soil Maps, and the National Soil Map, coordination is a key word if the tight time-schedules shall be followed.

The communication lines must therefore be held open at all times, so that possible bottlenecks can be eliminated immediately.

A person standing besides the production lines should also have the ability to foresee the unexpected. I can only support the decision already taken, that a Project Coordinator is attached to Zam-009.

All the above recommendations are based on the assumption that all the key personell at the production lines, stays with the project up to the end of 1991. Measures should be taken to ensure this !

Recently there have been a considerable increase in staff at the SSU (persons who have returned this autumn, from studies abroad are: The Land Evaluator, a Soil Correlator, and a Soil Surveyor).

With the present staff attitude towards the completion of both the District - , and the National Soil Maps, I believe that this can be achieved within the given time limits - with the reservations stated above. .

Appendix IX

Detailed Work-plan for the National Soil Map programme.

Presented for the Cartographic Sections at both Land Use Branch, and Survey Department on the 1st of December 1989, together with Fig. 7.

1. The Legend. Responsibility: Soil Survey Unit (SSU) - National Mapper (NM), and Soil correlator (SC).

It would be beneficial for the progress of the whole programme, that decisions are made as soon as possible regarding mapping units on the final map, their classification (based on Physiography / Geology / Soil-categories), and their size (minimum size unit), and necessary simplifications regarding the complex form of some polygons.

With the five Provincial maps and reports available, and with the general knowledge of the soils in the rest of Zambia, there will not likely be many new soil types in the remaining four provinces (Central-, Lusaka-, Southern-, and Western Province).

It is therefore recommended to choose a type of legend which will allow the cartographers to start on the National Soil Map sheets as they become available from the SSU.

It would for ex. have been possible to start to work on the Kasama sheet fairly soon, if the above mentioned details were agreed upon.

2. Transfer of soil information from provincial maps to the National Soil Map.

- a. Border adjustments between the neighbouring provincial maps, (LUB) - to be approved by NM & SC.
- b. Polygon changes; complex delineation and size adjustments (NM & SC).
- c. Re-coding of units - revised classification (NM & SC / LUB).

3. A Flow Diagram for the complete repro. -work (Cf. Mansa District map-sheet). This is very useful for the set-up of short-term work-plans which involve cooperation between Land Use Branch (LUB) & Survey Department (SD).

Responsibility: Cartographic Section, LUB.

4. Peel-coat preparation and peeling of at least 200 peel-coat sheets.

Responsibility: LUB

5. Repro. I - negatives produced from peel-coats.

Responsibility. : Cartographic Section SD.

6. Screening Responsib. : LUB

7. Repro. II - Final negatives for printing / Text setting ? Responsib. : SD.

8. Proofs - Responsibility: SD.

9. Proof-reading of four sheets. Responsib. : NM & SC (SSU)

10. Corrections after proof-reading Responsib. : LUB & SD.

11. Final printing films for colour printing ! Responsib. : SD.

