club du sahel

a trans-sahelian railway and the development of the sahel

preliminary study of the potential effects of a heavy-duty east-west transport axis on the long-term development of the sahel

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A TRANS-SAHELIAN RAILWAY
AND
THE DEVELOPMENT OF THE SAHEL

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Preliminary study of the potential effects of a heavy-duty East-West transport axis on the long-term development of the Sahel

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FOREWORD

Mauritania, Senegal, Mali, Upper Volta and Niger, the Sahelian countries of West Africa form a vast entity from the Sahara Desert to the well-watered countries along the Gulf of Benin.

The drought served to draw international public opinion to the situation experienced by these countries where sparse rains fall during a short - unpredictable - season. The drought triggered not only manifestations of solidarity to provide emergency aid but ushered in a period of careful thought on the region's long-term future and the strategy needed to pull the region out of under-development and decrease its vulnerability to drought.

And thus the "Sahel Club" was born, uniting Sahelians and members of the international community determined to define and work on fulfilling a long-term development strategy.

With this in mind the French Ministère de la Coopération requested SEMA to reflect on a long-term solution to the problem of transportation within the region and the immediate need for a trans-Sahelian railroad linking Dakar to Niamey.

Would such a rail link contribute to developing the Sahelian countries ? Would the outcome justify the input ?

The results of this intellectual exercise are presented in this - very preliminary - report, not to be confused with a feasibility study. Its sole aim is to attract attention to the importance a trans-Sahelian link could have for development.

SUMMARY

Considerable difficulties riddle efforts to build a trans-Sahelian transportation link to handle heavy traffic between Dakar and Niamey and to interconnect with the railroads penetrating West Africa. No single segment alone in the network could be sufficiently profitable to justify constructing it.

A global approach was thus selected based on hypothesis that in the year 2000 Dakar and Niamey would be linked by rail-road. Its a priori route was plotted and the transport rates set. And hence in the year 2000 with this most plausible development scenario to work with for the Sahel, efforts sought to measure the effects such a railroad could have on development and determine whether a posteriori justification existed for having built it in the first place.

Results are worthy of interest :

1. Thanks to the trans-Sahelian railroad the industrial development of West Africa lent itself to a different type of structuring. The way roads inland now lie, encourages the development of industrial poles along the coast with only subordinate industrial development of the landlocked countries, placed in a depressed position because of the structure of the transport system. The creation of a trans-Sahelian axis would equip the inland countries for autonomous, far more rapid industrialization, conditioned by the development of their home markets.

2. The trans-Sahelian link provides landlocked countries with more reliable connections with the coast and with greater assurance that, should drought recur, supplies can be properly conveyed.

3. The traffic forecast on these new railways - about an annual million tons by the year 2000 - should more than cover operating costs. The creation of these new channels of communication should serve to increase traffic on the existing roads and encourage substantial additional financial flows.

4. Further, the economic activity induced by the new line should justify the sizeable outlay for its construction.

Caution was the byword in making quantitative estimates. This being a very preliminary, perspective study, estimates only have the weight of plausible orders of magnitude.

Both qualitative and quantitative observations confirm that the idea of building a trans-Sahelian railway is far from absurd and could even be a very important component of the autonomous development aspired to by the inland Sahelian states, and hence the idea merits careful study.

That is why an approach to explore this idea in greater depth has been proposed.

CHAPTER 1 - USEFULNESS OF LONG-TERM REFLECTION ON THE TRANSPORT SYSTEM IN THE SAHEL

1.1 - THE TRANSPORT SYSTEM IN THE SAHEL AND PRESENT SHORTCOMINGS

Two glaring differences appear when we compare a map of the transport system in West Africa and a similar map for Western Europe or North America :

- there are far fewer links in the communications network in Africa, which is easy to understand because in West Africa the population density is much smaller and the level of economic development much below that of the industrialized countries ;

- the second difference is more surprizing. The European and American systems are composed of veritable networks of roads, railways, waterways, flowing standardized networks stretching over vast areas, networks that are more or less finely meshed, depending on the region, but all of which are designed for easy movement to all four cardinal points.

West Africa might be expected to have the same type of network, although more widely meshed because the area is less highly developed.

But this is not the case. The navigable waterwyas form a system composed of isolated stretches that do not flow into each other or even form a network. The Senegal and Niger rivers : a glance at the map may erroneously give the impression that they should be a chief contributor to developing the region. In fact they play a negligible role, a long way from the very important role - with due allowances for differences in developing levels - that, for instance, the Rhine-Danube plays in Europe.

The term "railway network" is a misnomer since the "system" comprises mainly links from the main ports to more or less distant points inland ; these segments are not even linked together to form a network.

At the beginning of the colonial period thought was given to developing the rail lines into a network, but the thought never materialized.

The road system is more worthy of the name "network" although the links are very heterogeneous... from the paved road to the earth track and down to the primitive trail. Here again more often than not the best roads run from the ocean inland. Often it is far easier to travel from the ocean inland or vice-versa than from one landlocked country to another. We are confronted with a transport infrastructure system which does not form a meshed network and which favours coast-inland traffic to the detriment of the inter-regional transport.

The system is pregnant with consequences.

In Europe thanks to the development of various networks transportation from one point to any other point is easy, and the cost of East-West transport is generally the same as North-South transport. The transport system has not inhibited the development of inter-regional and, subsequently, international trade. Quite the contrary. As manmade barriers between regions and then between states disappeared the configuration of the transport networks unquestionably firmly bolstered European economic integration and the stupendous growth of trade.

The question come to mind in West Africa whether the creation of economic communities, West African Economic Community (CEAO) or ECOWAS will suffice to enhance trade relations between the West Africa countries, especially between the landlocked Sahelian countries and whether the high cost of international transport on poor roads and rails does not stem trade just as much as customs barriers.

In Europe landlocked regions and countries have several ways to reach the ocean, and transport costs are essentially the same, so that countries such as Switzerland or Austria are not victimized by technical - or political - obstacles that may strike any of their outlets to the sea ; for them this means a great degree of security in international trade relations.

Obviously we cannot say the same for the Sahelian states which have just one way that leads to the coast. Other oceanward axes are of such limited capacity or have such high transport rates that full reliance is generally placed on one and only one "way out".

The transport system of West Africa was quite clearly designed at a time when developing the region meant developing the so-called "cash" crops for the colonizers' home market and conversely bringing in manufactured goods from the "mother country" for sale on the "privileged markets". Roads running inland from the ports met the developed needs of that era. The regions only traded with the "mother country" ; for the rest each region lived in a quasi-closed economy, and participated in extremely little inter-regional trade.

With such an economic system, development rather than being considered as "autonomous" is seen as the extension of the economic development in the mother country, with the transport system reflecting this concept "in the field".

Now, for the independent states, the concept of development is something quite different. Efforts to build economic communities in West Africa reflect determination to ensure integrated economic development for the region as a whole. The Sahelian states, grouped into the Permanent Inter-state Committee for Drought Control in the Sahel (CILSS) and in the Sahel Club have built up a development strategy aimed to ensure food self-reliance for the Sahel and to achieve autonomous development for the region. They have recognized that at least in the early stages these objectives can only be attained on a regional basis.

Is the present transport system, designed when conditions were totally different, adapted to the desired autonomous development ? Can it serve as an instrument for the economic integration of the region ?

A priori the present configuration of the West African transport system does not lend itself well to attaining these objectives. Whatever be the efforts made to further the establishment of a common market, if the transport system is not restructured, the enclaved countries, it is to be feared, will remain separated by the high cost of inter-state transport, and the Sahelian common market will merely be a string of words.

The configuration of the transport system, of course, is not the only obstacle to the integrated development of West Africa. Many an expert report has emphasized that the present system could be more efficiently run, that road maintenance is poor and that certain railways are underexploited.

The West African transport system, hence, is far from satisfactory. Conveyance of emergency aid during the last big drought brought the major shortcomings to the fore :

- because of poor management the normal routes for traffic from the ports to the inland regions threatened by famine were quickly congested ;

- because of the lay-out of the system there were no alternate routes capable of handling heavy traffic ;

- the poor quality of the secondary network and the inter-state links hindered the distribution of emergency food rations and inter-regional trade.

This explains the food losses reported by several observers.

1.2 - THE IDEA OF A TRANS-SAHELIAN TRANSPORT LINE AND ATTENDANT DIFFICULTIES

A certain number of measures have already been recommended or are being studied in order to remedy the above situation. They are designed either to improve or extend the existing system. Ameliorative actions concern road maintenance, railway management, building feeder roads or investments for major agricultural development operations, paving roads, etc.

These types of measures are unquestionably vital and will help remove certain bottlenecks and improve transport throughout West Africa, especially in the Sahelian states.

But they are short and medium-term measures that will not change the roots of the current transport system's configuration which, as we already said, is ill-adapted to the autonomous development of the Sahelian states.

Long-term measures and the adaptation of the transport system to the objective of the Sahelian states still offer food for thought.

Such reflection can be approached from two angles : first we could use the classical approach, i.e. remodel the existing system gradually to meet traffic needs. This could be done through large scale operations. It would require modelling and simulation to be able to predict traffic flow increases during the forthcoming years and to plan network expansion and new routes.

This approach has some obvious advantages :

- the transport system is used optimally at all times and adaptive work matches the flow pattern ;
- it avoids recourse to - risky - medium and long-term forecasting.

But we might ask whether there is not a better approach, which goes further in satisfying the Sahelian states' long-term objectives.

Would application of this method lead to the development of a transport system basically similar to structure inherited from the colonial era, a system which does not completely satisfy the objective of regional integration ?

Up to now every time that thought was given to building an East-West railway connecting two existing lines running inland, from the coast, an insurmountable obstacle appeared on the horizon, i.e. the traffic predicted for the new link was so light that the proposed investment was not profitable.

It was unquestionably appropriate not to make this investment. The absence of traffic between two inland countries was not only the result of the absence of well adapted transport system but also deeper reasons such as the narrowness of inland markets and, more generally, the low level of national economic development. Would opening a new rail line have been enough to stimulate the traffic needed to make the investment pay within a reasonable length of time ?

Will the situation ever change ?

If we continue to broach the problem of transport systems in this manner, there may be a risk of falling into the following vicious circle :

Traffic does not justify the construction of the East-West link. Therefore the transport system continues to grow around the existing axes, "cropping in clusters". But as the countries develop, new activities are introduced, e.g. industries producing manufactured goods which have a certain latitude in their choice of sites. These industries choose locations where transport systems exist : their structures depend on the transport availability. The traffic on the East-West line is expected to grow very slowly, and the transport system still continues to develop just like in the past, strengthening the economic structure polarized around the system, etc...

In the long-term, is there a risk that by the end of the century there will be a transport system in West Africa that is far better than the present system, well adapted to the traffic flows of the time but which, structurally, will not be much different from the present system, and will continue to favour the North-South, coast-inland links. Such a system will have triggered economic development that might be termed "brilliant" but which will be largely externally-oriented and only partly meet the objectives of Sahelian economic integration and autonomous development

The following, far less classical, approach might be considered. At the outset let us assume that there is a transport system with East-West links connecting the inland countries, a link we will call the "trans-Sahelian line" which could impel the higher degree of economic integration aimed at by the states. There is reason to think that as a result these countries would undergo a different type of economic development. Certain new activities would be introduced because of the existence of the new transport system, and the economy would develop a different structure.

There are also reasons to believe that since the new transport system would bridge markets therebefore separated, new activities would become economically feasible. Let us look from a long-term vantage point and weigh the advantages of this "different" economic development to the Sahelian states. Then let us take these benefits against the constructions costs for the East-West line. If the cost-benefit ratio favours our transport system, we will have an a posteriori justification for its construction.

In sum, the first approach most cautiously considers that the transport system should go hand in hand with the development of needs while this second approach more boldly has the transport system play a role in orientating the economy and in developing the lands, justifying options by weighing their long-term effects.

This approach is open to several criticisms :

- the cost of building a heavy transport line, be it a motorway or a railway, to link the Salelian states would be very high. We will discuss the cost evaluation further on.

  It should be pointed out that building an axis in a relatively flat savannah country does seem to involve very special problems and that the per kilometre cost should be far lower than, for instance, the railroad being built in Cameroon or in Congo, and, all the more so the trans-Gabon railroad, when construction operations have to overcome problems of vegetation, climate and landscape that are far more difficult and increase the costs.

- a transport line between the Sahelian countries is, in any case, useless ; these countries have the same climate, the same productions and do not have and will never have anything to sell to each other. The flow of traffic is, and will continue to be far more important between the Sahelian countries and the wetter equatorial countries.

  This type of rationale is at present, at least partly justified. In countries where the economy is still very traditional and where 90 per cent of the population engages in agricultural activities production is far more competitive than complementary. But had this same line of reasoning been applied at the beginning of the 19th century in Germany and France where the climates are similar and natural resources not very different (iron ore, coal, potassium) the trade relations would have remained at a low level and hence the transport system bringing together the two economies would have remained little developed since the general belief would have been that trade would be limited to Bordeaux wine for Munich beer. Emphasis would then have been placed on the link to Spain where citrus fruits and metal ore were available.

Experience has shown that ease of transport between two countries coupled with the subsequent removal of artificial trade barriers - without abolishing competition between products - has led to spectacular development of trade, division of labour and an economy so structured as to recognisably benefit both countries.

The Sahelian countries cannot indefinitely specialize in agriculture and animal productions. Their economies will have to become diversified. This will entail choosing between diversification to develop a high degree of complementarity - but this will require a well adapted transport system - and diversification to develop each of the economies independently, striving, harder to strengthen bonds with foreign countries than to enhance possible regional co-operation.

- This approach counter weighs high infrastructural costs with hypothetical earnings cast in the far distant future ; this type of criticism actually applies to all long-term investments. But we are dealing with transport infrastructure, it should be noted that there are numerous examples of infrastructures that would never have been built if only their short or medium value had been weighed in the pendulum. This was the case for many railway networks in Europe and in North America whose medium-term profitability was not at all certain (just think of the number of railway companies that went bankrupt in the 19th century). Yet their role was decisive to the economic development of a region, and the effects were unquestionably beneficial for the communities they served.

- and then lastly one opinion holds that building an inter-state transport system is not the most urgent investment for the Sahel. We cannot plead that it is mandatory for the immediate future. But what prevents us from thinking about the long-term future and trying to prepare for it ?

1.3 - WHY BUILD A TRANS-SAHELIAN RAILWAY ?

We have seen that there are many, often well founded reasons for not building a trans-Sahelian railroad. On the other hand it is easy to see the advantages of such a construction for the Sahelian states. Three stand out clearly :

- first, as we said, an increase in the economic activity of the Sahelian states. At present the Sahelian states have a narrow market for industrial consumer goods because their economies are little developed and the majority of the people have very little monetary income. Furthermore the transport system keeps the markets so disconnected that unified trans-Sahelian industrialization is not possible. This explains why none of these countries have finished products to place on multi-state market.

  Regrouping these markets coupled with the regional economic development may well facilitate the establishment of multi-state industries and, hence, perhaps make a substantial contribution to developing a hitherto embryonic industry.

- second, more reliable connections for each of the Sahelian countries.

  Building an East-West line to interlink the various routes running inland would provide the lanlocked countries with a second route to the ocean and consequently increase their communications security by :

  . equipping them better to cope with peak traffic,

  . safeguarding them against risks of having traffic outbound to the ocean interrupted by strikes, technical failures or political events.

- third is the advantage of better organized economic space. When transport systems are structured to favour trade with abroad, economic activities tend to cluster around the main ports and, to a somewhat lesser extent, around the roads running inland. A trans-Sahelian route would redirect economic growth so as to ensure a better equilibrium in West African activities and physical land development that more closely meets the wishes of the Sahelian states.

In the following chapters we will try to present these advantages in greater detail.

CHAPTER 2 - THE OBJECT AND METHOD OF THIS STUDY

2.1 - SCOPE

Evaluating the possible effects of building a trans-Sahelian railroad on the development of the Sahel is a most difficult undertaking. Several types of difficulties cloud the horizon, viz.

- the main one unquestionably is the need to adopt a long-term vantage point. Hypotheses have to be formulated concerning the evolution of the Sahelian countries, identifying factors within and without the Sahelian countries that will be of major importance to the evolution of the region. Scenarios must be created and then evaluated to see how probable they are, and then they have to be redesigned to cover each of two situations : (1) the trans-Sahelian railroad is built, (2) it is not.

- then come the problem of the need to quantify the effects of building a railway. Increased security in communications is in itself difficult to express in numbers. And evaluating the effects of new industries enrooted in national economies that up to now have been littled developed is also not easy.

Therefore this report cannot include a feasibility study, or even a pre-feasibility study for a trans-Sahelian railroad.

We are trying to demonstrate that building this railroad would have effects on the development of the West African states and the structuring of their economies that may be substantial enough to justify the investment.

We propose to focus attention on the value of a trans-Sahelian line, to show why such a project should not a priori be left out of long-term Sahelian development plans, and why, quite the contrary, it merits deeper consideration ; then we want to suggest some ways of conducting a related depth study.

2.2 - METHOD USED

We already indicated that the method used consists of a global evaluation of the effects of an East-West transportation line inter connecting the various roads running inland.

More specifically we intend :

- to define an, a priori, set of hypotheses concerning this link :
  - . type : railway or paved road,
  - . approximate itinerary,
  - . transport rates based on distance, type of goods, size of consignment, etc.
- to examine, should the link be built, what activities - including indications on size and siting - could result from the existence of such a link ;
- to try to determine what effects this link will have on the economy :
  - . qualitative effects on the use of space and the structure of the economy, and,
  - . quantitative effects : value added thanks to the new activities.
- to collate these effects with the estimated construction costs ;
- to try to assess traffic flows on the new link and see whether such flow can offset operating costs.

2.3 - HYPOTHESIS

. Railway or motorway ?

The first question we might ask is whether the trans-Sahelian link should be a railway or a heavy traffic paved motorway. There are reasons for choosing either. We preferred a railway to link up with the existing railways running from the coast because :

a) - a railway requires a much higher initial investment than a paved road, and therefore it may be difficult to prove that it is profitable. Showing that the profitability level is acceptable will be a powerful strike in favour of the project.

b) - a trans-Sahelian railway linking together existing railways will mean creating a bona fide West African network and facilitating transport between the countries it traverses, without reloading goods. This would not be the case for motorways ; reloading costs (road and rail) would still be relatively high.

c) - the Sahelian countries concerned at present do not have oil, and therefore were severely affected by soaring cost of energy. This may happen again, or they may be handicapped by the problem of bringing in supplies of oil products. Some experts time this difficulty for the 1980-90 decade, in any case, it seems inevitable in the long-term future. Rail transport, which is energy saving for the Sahelian countries, seems to be a cautious solution.

. Itinerary

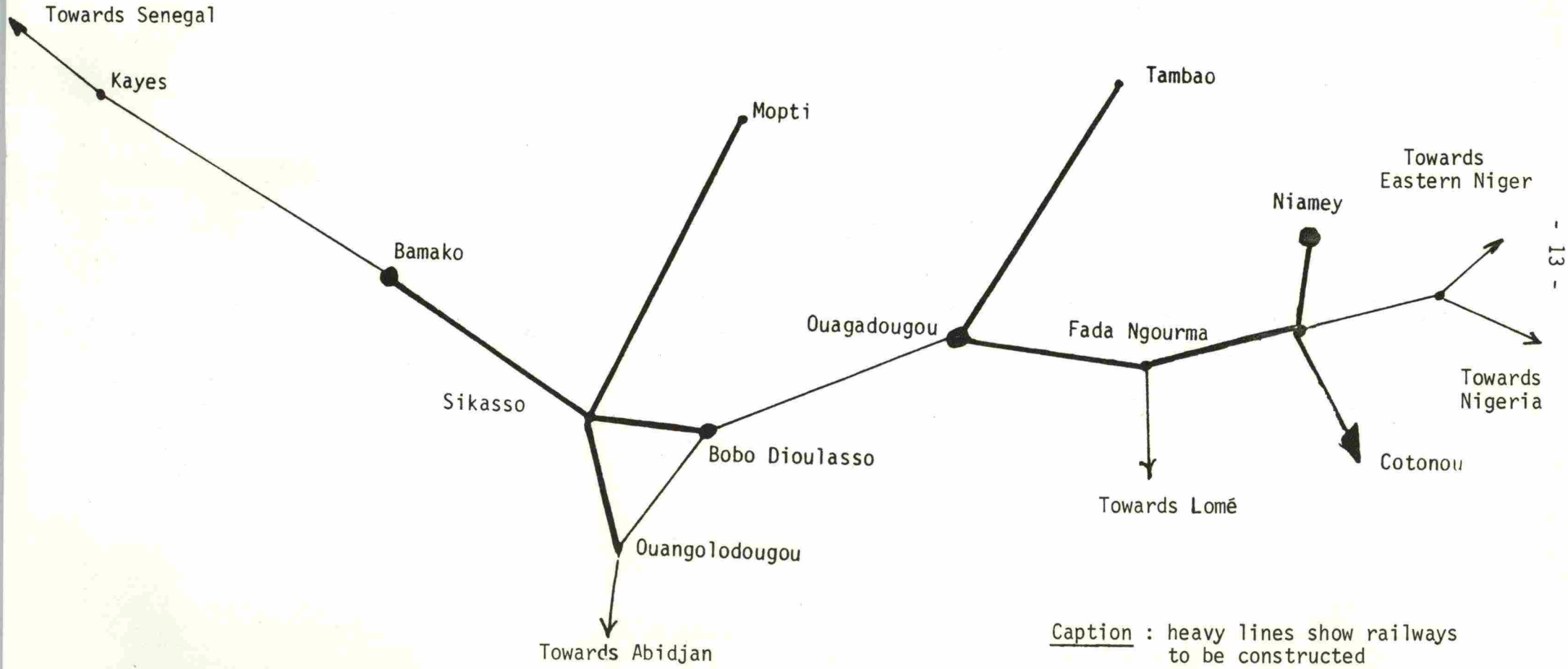
The following itinerary was provisionally selected :

- a link from BAMAKO to the ABIDJAN-NIGER railway as follows : BAMAKO - BOUGOUNI - SIKASSO and SIKASSO - OUANGOLODOUGOU thus ensuring a direct route from Mali to ABIDJAN. The SIKASSO - BOBO DIOULASSO link would connect Senegal and Mali with Upper Volta and Niger ;

- link from OUAGADOUGOU to NIAMEY and W du NIGER.

It was further assumed that the OUAGADOUGOU - TAMBOA link would be built to evacuate manganese ore from Tamboa.

During the study it appeared that the inland delta region of River Niger could be expected to undergo substantial development thanks to the potential use of the irrigable lands there. We wondered whether it would be advisable to build an East-West railway North - and instead - of the aforementioned itinerary or rather a SIKASSO - MOPTI feeder line. We opted for the latter.



Caption : heavy lines show railways to be constructed

. Rates

Hypothetical rates were calculated to ensure that transportation on the trans-Sahelian link would not cost more than transportation on the coast-inland routes. These hypothetical rates, thus, abolish the preferential rates now applied on coast-inland transport in comparison with transport in other directions.

We have used information on rates currently applied by the Abidjan-Niger Railroad and recent rates studies, assuming that these rates, in constant francs, would not change substantially between now and the end of the century. In any case, the hypothesis on equal rates regardless of direction was more important for the study than the absolute value of the cost per ton per kilometre.

The following type of rate structure was used to help us clarify our ideas :

- for heavy goods, a graduated rate of ± 9 CFA francs per ton/km for distances under 500 km gradually decreasing to ± 5 CFA francs per ton/km for distances of ± 1,500 km ;

- for manufactured goods, a graduated rate of 15 CFA francs per ton/km for distances under 500 km gradually decreasing to ± 8 CFA francs per ton/km for distances of 1,500 km.

. Hypotheses on evaluating the effects

Obviously it is only worthwhile assessing the effects of the trans-Sahelian link on a very long-term basis. During the 1980-90 decade, for instance, the economic development and diversification in the Sahelian countries will not suffice to justify such an investment.

Some perspective studies have been conducted on the Sahel for the period running from 1977 to 2000. The development programme and strategy designed by the Sahel Club and adopted by the Sahelian States also covers this period. That is why we decided on year 2000 as our deadline, assuming that the trans-Sahelian railway would be built by that time. We tried to see what the effects of the railway could be during the last few years of the 20th century.

Step one we felt had to be setting the bounds within which the study on effects could be conducted and defining :

- the geographical setting : what regions would be affected by the trans-Sahelian link ; these would be the regions for which effects should be studied ;

- the demographic picture : which populations in the year 2000 would be involved ;

- the economic setting : what will be the overall development levels in the countries concerned and the major economic trends by the year 2000 ?

The following chapter is devoted to the scenario that may be taking place in the Sahel in the year 2000.

CHAPTER 3 - A POSSIBLE SCENARIO TAKING PLACE IN THE SAHEL IN THE YEAR 2000

It seems appropriate to emphasize that the following scenario aims exclusively at setting the stage and ensuring the coherence of sectoral studies.

We intend to look at the economic effects of a trans-Sahelian link on the Sahelian economy, towards the year 2000, and in order to do this, study certain industrial sectors which could have important effects. A certain number of hypotheses have to be formulated to avoid inconsistent reasoning from one sector to the next ;this is the one and only purpose of the scenario we will call "The Sahel : year 2000".

We have sought to construct a plausible scenario supported by serious perspective work that has been completed and applies to the region (1). Quite obviously, however, it would have been possible to elaborate other scenarios that are just as plausible or equally probable. We merely aimed to set the stage, realistically, and ensure coherency in the sectoral work.

3.1 - THE GEOGRAPHIC SETTING

This study includes five of the eight countries generally called the Sahel that form the Permanent Inter-State Committee for Drought Control in the Sahel (CILSS), Niger, Mali, Upper Volta, Senegal and Mauritania.

The Cape Verde Islands, for obvious reasons, are not involved in a trans-Sahelian transport link. The Gambia, a narrow strip of land on both sides of the Gambia River has its own transport system and therefore is only marginally concerned with the trans-Sahelian transport link. Lastly, Chad is, naturally, more closely connected with the Central African states than with the West African Sahelian states, therefore, a priori, a heavy transport link with Niger hardly seems justified, even in the year 2000. For this reason it was not included in this study.

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(1) A bibliography of the main reference documents is appended to this paper.

Certain zones in the region are marginal and will only be slightly - or will not be - affected by the trans-Sahelian transport link, e.g. the desert zones and the adjoining areas called "the Nomads' Sahel" ; hence our study excludes most of Mauritania and the whole northern parts of Mali and Niger.

Attention has focussed on a strip of land running from Dakar to the Eastern border of Niger, comprizing mainly the so-called Soudanian and Soudano-Sahelian climatic zones plus the Sahel peopled with sedentary populations in the five states listed above. The irrigable-river valleys lying outside these geographical zones were also included.

Not all the regions within the area will benefit equally from the construction of a trans-Sahelian transport link ; some undoubtedly will hardly feel the effects. Yet we felt that this strip of land formed a rather homogeneous geographical zone worth studying as a unit.

On the other hand certain parts of countries located further South, in particular North of Ivory Coast, will no doubt feel the impact of this link. They have not been included in the zone to be studied ; we will only identify some opportunities that emanate from the opening of this link, and traffic that may be generated accordingly.

In sum, the study covers a stretch of about 3,000 km of land running from East to West, with widths varying between 300 and 600 km. We proposed to study the effects of a Dakar to Niamey link (over 2,000 km as the crow flies) on the economic structure and the development of the zone.

3.2 - THE DEMOGRAPHIC SETTING

In 1965 this zone had 15 million inhabitants. The current population growth rate varies between 2 and 3 per cent, depending on the country. What will be the population in the year 2000 ?

The answer depends on future variations in growth rates and population migration rates. Population growth rates are not expected to change much between now and the year 2000 ; on the other hand, several migratory movements could be envisaged, both within the zone and to places outside the zone.

POPULATION GROWTH RATES :

Mali	Mauritania	Niger	Senegal	Upper Volta
2.4	2.3	3	2.4	2

A SCET International-SEDES study (1) on defining an anti-drought strategy for the West African Sahel, envisaged three population scenarios :

- the first scenario presents a continuation of the population trends recorded prior to the 1968-73 drought, characterized by :

  . continued emigration out of the Sahel,

  . inside the Sahel, migration from low potential to higher potential zones such as the irrigated zones, or the well watered lands free of endemic diseases,

  . growth rates in capital cities dropping from 5.2 per cent in the 1975 to 1985 period to 4.6 per cent after 1985.

  In the zone studied, this projection indicates that the total population will be 35 million by the year 2000, of which 5.2 million will reside in the capital cities.

- the second scenario hypothesizes emigration outside the Sahel and large scale intra-Sahelian migration to the higher potential zones and the capital cities. The projected result is a population of 33.5 million, with 10 million in the capital cities.

- the third scenario envisages slower emigration outside the Sahel, a better balanced population distribution within the zone and seriously curbing the flows of population to the capital cities. The result is a projected population of 38 million of which 4.2 million reside in the capital cities.

We have chosen the following scenario which, if not the most probable, at least appears to be most plausible :

- continued population expansion and emigration as per the trend observed prior to the drought ; (Scenario I in the above mentioned study). This presupposes, in particular, that food crop development between now and tne year 2000 is sufficiently fast to allow emigration to level off at rates close to those observed up to now. This also presupposes that the per capita income increases, otherwise the attractions of the large coastal capital cities such as Abidjan, Accra, Lagos and European cities will tend to encourage emigration.

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(1) "Essai de définition d'une stratégie anti-sécheresse dans le Sahel de l'Afrique de l'Ouest", SCET International-SEDES, December 1975.

- relocating population settlement areas (migration towards higher potential zones) within each state ; there seem to be very strong sociological reasons that at present hold back massive migration between the countries.

- massive emigration to the capital cities. Since capital cities will continue to seem extremely attractive it will be very difficult to control urban growth. On this point, therefore, the hypothesis in Scenario I seems hardly probable and the capital city population figures seem low.

According to these hypotheses the zone defined above will have 35 million inhabitants by the year 2000, which corresponds to an average annual growth rate of 2.5 per cent, between 1965 and 2000.

Out of these 35 million it does not seem impossible that at least 6 million live in the capital cities, as against 1 million in 1965.

Map I showing the possible population distribution in the year 2000 was drawn up using these hypotheses. This map served as the basis for determining production and consumption of manufactured goods. For reasons of convenience Map I also shows urban food requirements (1)

3.3 - THE ECONOMIC SETTING

The main features of this zone are :

1 It is still very "under-developed", with many countries counted as being among the poorest in the world. In the five countries the gross national per capita product in 1972 was considered to be US $ 128.

Disparities from one country to the next and within each country are rather sizeable :

GROSS NATIONAL PRODUCT, PER CAPITA, 1972 (in US $)

Mali	Mauritania	Niger	Senegal	Upper Volta
70	175	120	285	70

(1) The per capita consumption rate was assumed to be 300 kg of plant and dairy products, meat and fish per year.

SAHEL

Demographic Distribution in the year 2000

- Population figures in 1000 inhabitants
- Urban nutrition needs in 1000 t.
  (vegetable, meat, milk, fish products)

MAP N° 1

Since regional accounts do not exist it is almost impossible to calculate the per capita GNP in our zone of study. But everything seems to indicate that it is similar to the overall average (the high GNP mining regions have been omitted, as have been the desert and sub-desert regions where GNP is especially low).

2 This is relatively stagnant and, in some cases, an "under-developing" region. During the 1960s in more than one country (Senegal, Niger) the gross national product grew slower than the population (1.6 as against 2.4 per cent in Senegal, 2 as against 2.7 per cent in Niger), and in Mali and Upper Volta the GNP grew barely faster than the population. Mauritania is the only place where the increase was important : undubitably thanks to the mining industry GNP increase of 7 per cent and a population increase of 2.2 per cent.

The sustained drought caused the agricultural production to drop which in turn depressed the GNP in 1973. Since that time the general climatic conditions have improved and thus probably propped the GNP although even now it probably does not exceed US $ 130 per capita.

3 Most of the zone is agricultural and, except in Senegal,close to 90 per cent of the total population works the land.

% OF THE TOTAL POPULATION WORKING ON AGRICULTURE (DOLLARS)

Mali	Mauritania	Niger	Senegal	Upper Volta
91	85	91	76	89

4° Income differences in the zone are considerable ; the ratio of 1 to 10 has been observed between the rural and urban income levels, a financial gulf that seemed to widen during the 1960s.

This indicates that the monetary income of the rural population, despite the development of the so called "cash crops" is extremely low, and has tended to decline during the last few years and cannot support a wide market for manufactured goods.

POSSIBLE TRENDS BETWEEN NOW AND THE YEAR 2000

a) - Basic problem no. 1 for the zone is to guarantee supplies of foodstuffs... not only in years when rainfall is normal but also during periods of sustained drought.

This presupposes a considerable increase in food production to cope with changes in the size of the population, to increase the food intake level, which at present in many cases is far too low, and to build up grain stocks in preparation for periods of rainfall deficit. This implies reversing present trends. FAO predicts that if the trends of the pre-drought years continued, the zone would soon have a grain shortage, even during normal years, and hence would have to import increasing quantities of cereals which, probably, would have to be financed by international aid.

The trend can be reversed :

- Agriculture is still practised in the traditional manner throughout the zone, mainly through extensive rainfed cropping (with long periods of fallow). Revolutionary plans are needed to advance to a stage of intensive agriculture on much of the lands by the year 2000 (with shorter periods of fallow, use of animal power, application of natural or artificial fertilizers, etc.).

- There is still little irrigated cropping and cropping on water receded lands. Yet the potential for the irrigable lands is considerable, especially in the valleys of the Senegal and Niger rivers and the Volta valleys.

The objective recommended by the Sahel Club and approved by the African states seeks :

- to double the yields of traditional rainfed cereal crops by the end of the century, which implies much higher land productivity ;

- to use irrigated cropping techniques to meet the total demand for rice, wheat and sugar and part of demand for traditional cereals.

These objectives are quite compatible with the potentials of the Sahel. But to achieve them will require a big effort by the Sahelians (changing cropping habits radically) and the International Community (financing productivity operations, dams and hydraulic installations, etc.).

b) - During the last fifteen years special efforts have been made to further the development of the so-called cash crops (essentially groundnuts and cotton) mainly to feed the export market.

Indeed these development efforts should be continued since increasing exports will be vital for the Sahelian countries in the forthcoming 25 years. First because shifting from extensive to intensive agricultural techniques will require the use and to a large extent the importation of modern factors of agricultural production, in particular fertilizers. And second because economic development will require a large increase in imported manufactured goods, in particular capital goods.

Equilibrating the balance of payments will necessitate increasing exports, first and foremost exporting agricultural produce that is unprocessed or has undergone the first stage of processing. This explains why cash crops should be developed alongside food crops.

The traditional groundnut and cotton crops will probably be combined with cereal crops (the potential production from irrigable lands and from increased productivity obtained from rainfed crops in many regions should to a large extent meet the local cereal requirements and also make it possible to export part of the output to the neighbouring regions such as the Maghreb which may suffer from a cereal deficit, and products from stock-farming (when the herds decimated by the drought have been reconstituted and if a new animal production policy is adopted).

More income from grain crops than in the past may be expected to revert to the rural masses who thus will be able to purchase not only the products and goods they need for farming (agricultural equipment, fertilizers and pesticides) but also a significantly larger quantity of everyday manufactured consumer goods.

This scenario for agricultural development is presented on Map 2 which covers agricultural productions in the year 2000 in order to evaluate transport flows of foodstuffs towards the cities. The map is derived from the FAO and SCET-SEDES perspective studies and the Sahel Club's work. The production from rainfed crops is equivalent to the minimum needed to ensure the zone's food self-reliance, with one severe restriction i.e. that the daily diet only improve very slightly.

No consideration was given to animal productions i.e. meat and dairy products, since the development of this activity still seems too vague, nor to fishery products which might well impel a goodly amount of traffic.

c) - The mining industry as yet only covers phosphate in West Senegal and uranium in Niger. The size of both deposits gives reason to assume that towards the end of this century phosphate will still be exploited at the same rhythm as now and that Niger uranium operations will have grown since the "uranium rich province" is quite big.

Since it takes about 10 to 15 years to launch operations in other large deposits rough estimates can be made concerning mining in the Sahel for the 1985-90 period, with reference to the sites that have already been identified or are now being explored. Besides the two deposits mentioned above there are :

- the manganese deposit in Tambao, Upper Volta and perhaps at a later time, the manganese deposit in Ansongo, Mali ;

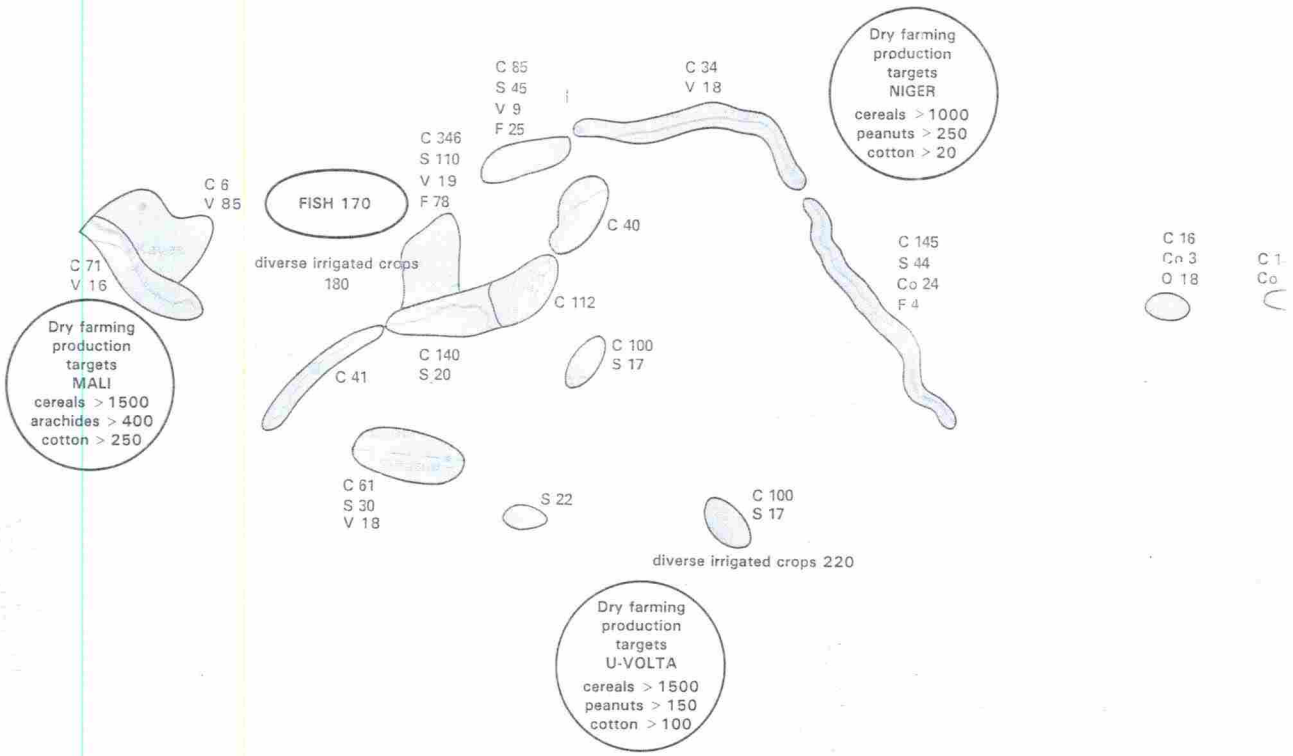
- the iron deposit in Falémé, East Senegal, if mining operations can be made profitable ;

- the phosphate deposit in W du Niger, if detailed studies confirm the validity of the deposit.

Within a much larger time frame we might assume that there are still two or three totally undiscovered deposits that, after being prospected could be exploited. All told the mining industry in the Sahel is rather small-scale ; unless something completely unexpected is discovered we can consider the zone to be poor in mineral resources. There are two exceptions :

- phosphate abounds and should serve not only to expand the export market but also to develop an industry that can meet the needs of agricultural development within the zone,

- Uranium may well play an important role by contributing to the economy - first and foremost to the budget - of Niger.



SAHEL

Possible farm production scenario in the year 2000

(• irrigation farming : C cereals - S sugar - Co cotton - V vegetables
- O onions in 1000 t - F forage in 10^6 forage units

• dry farming production in 1000 t.

• fish products in 1000 t.

MAP N° 2

will no longer be able to produce enough food. The Sahel had to depend on food relief during the drought ; this was exceptional but if the agricultural methods do not change the International Community will have to provide aid ad infinitum, which is unacceptable to all concerned. Under these conditions a trans-Sahelian link would not make sense so this scenario has been eliminated.

- and acting out a coherent development scenario including :

  . modernizing traditional agriculture by gradually replacing extensive crop and stockfarming methods by more intensive methods ;

  . the development of irrigated farming ;

  . increased rural incomes, narrowing the gap between urban and rural incomes ;

  . the development of industry based on home markets which also cater to the rural populations.

How can such change and development occur ? An optimistic hypothesis might predict that the GNP will rise from US $ 130 to US $ 250 per capita by the end of the century, which is equivalent to an annual increase of 2.6 per cent, and an annual increase of over 5 per cent in the gross national production. If development efforts are sustained this hypothesis could materialize.

A more modest hypothesis would predict a per capita GNP increase of from US $ 130 to US $ 250 i.e. 1.7 per cent per year with an annual increase of 4.2 per cent in the gross national production.

This is the scenario we used in assessing the value of a Sahelian transportation link.

We also hypothesized that the least developed of the developing countries would make faster progress and reach a GNP level of about US $ 150 per capita.

CHAPTER 4 - THE EFFECTS OF TRANS-SAHELIAN LINK ON VARIOUS SECTORS OF INDUSTRY

PRELIMINARY REMARKS

Obviously this study could not undertake a complete study of all the secotrs of industry that might be deeply affected by the trans-Sahelian link. We limited our choice to a few sectors which seem to have serious problems on moving inputs and outputs, because the construction of a trans-Sahelian route could a priori, have important effects on their development and structure.

Other sectors may also be concerned and the new route might provide a new impetus for their development.

For each of the selected sectors we worked out a double development scenario, showing the difference in development of the trans-Sahelian line is, or is not, built.

These scenarios of course are open to criticism. Efforts were made to propose plausible production levels, sites and traffic flows. But figures in this study should not be given too much importance. They are of only vague indicative value, and are not meant to reflect targets or precise forecasts.

Besides suggesting the sites and lines of production needed to express ideas clearly - but which should be used with great cirscumspection - we feel that the prime interest of these scenarios is to bring out the main trends and, even more important, demonstrate the differences in the structure of West African industrial development if the railroad is built, or if it isn't.

To make this unusual structuring more tangible, the sectoral development scenarios have been illustrated on maps. Each map includes a brief explanation of how the scenario was constructed and what justification there was for the underlying hypothesis. In the end we tried to draw a conclusion for each of the scenarios.

4.1 - CEMENT (MAP 3)

The assumption in Senegal is that most of the consumer needs will be met by the cement factory near Dakar. This study therefore is limited to studying production and consumption in the three inland countries (Mali, Upper Volta and Niger).

The evaluation of total cement consumption is based on a comparison with other countries when the present average per capita income is close to that predicted for Mali, Upper Volta and Niger in the year 2000.

The following diagram shows that an annual 20 kg of cement per person in the year 2000 is a conservative estimate and corresponds to 564,000 tons per year.

The urban consumption was restricted to 70 per cent of the total, to reserve enough for the heavy infrastructure work, i.e.

- urban consumption : 72 kg/inhab/year
- rural consumption : 7 kg/inhab/year

Rural consumption will be devoted in part to the irrigated farming plots. An average of 4 tons/ha of equipment gives us an annual figure of 0.17 tons/ha over a period of 23 years.

Map 3 uses this information to indicate possible cement consumption sites in the year 2000.

Can this demand be met ?

If a trans-Sahelian railway was constructed it could be as follows :

three cement factories located at known limestone quarry sites would produce the cement :

- DIAMOU in Mali
- TIN HRASSAN in Upper Volta
- MALBAZA in Niger.

Production capacities could be :

- DIAMOU
  - . Two-thirds of the Malian market ;
  - . 50,000 tons to Senegal ;
  - . 50,000 tons to Ivory Coast ;

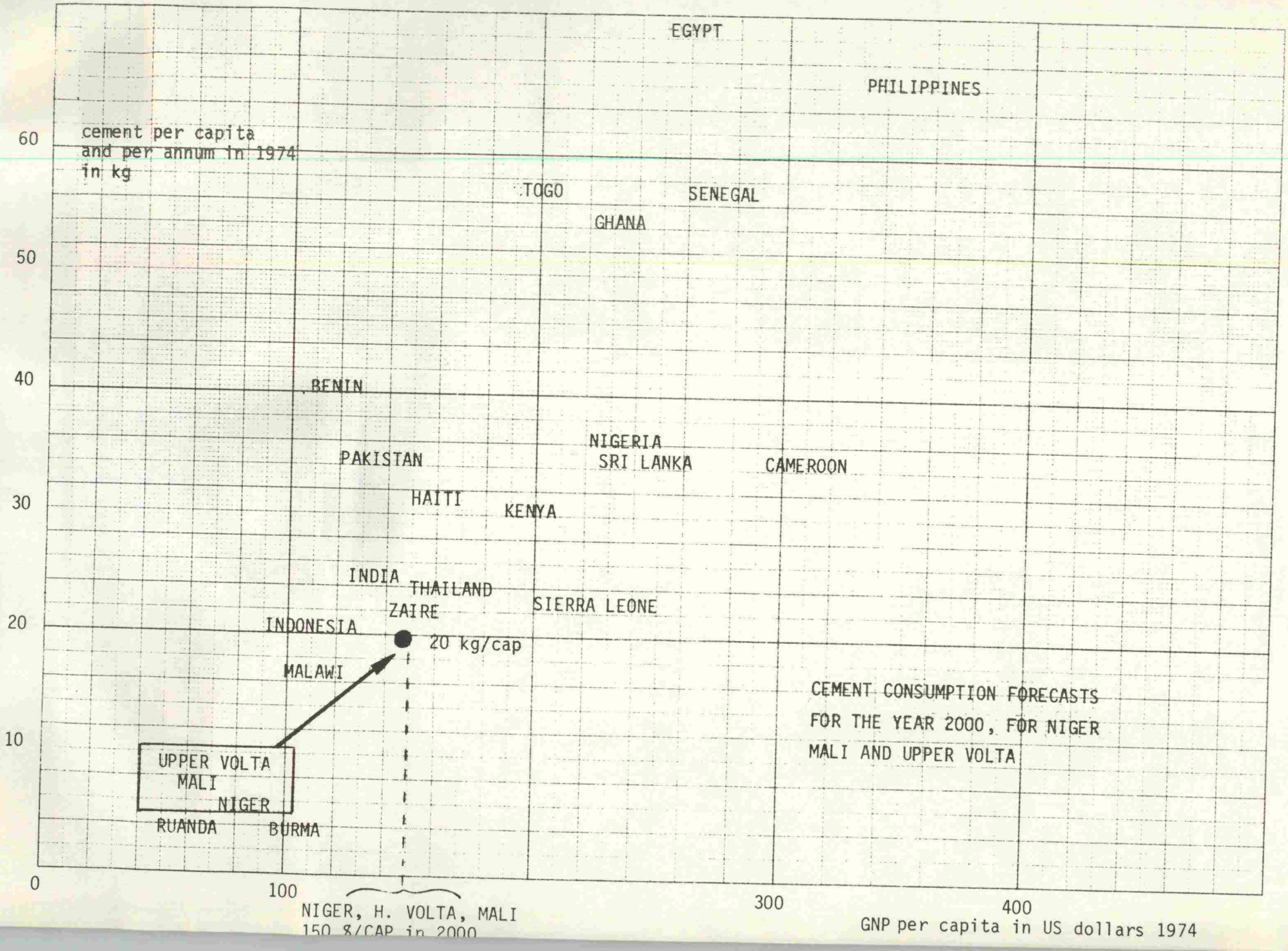
  260,000 tons

- TIN HRASSAN
  - . one-third of the Malian market ;
  - . the whole Voltaic market ;
  - . one-third of the Niger market ;
  - . 50,000 tons to Ivory Coast ;

  370,000 tons

- MALBAZA
  - . two-thirds of the Niger market ;
  - . 50,000 tons to Nigeria.

  130,000 tons


cement per capita
and per annum in 1974
in kg
60
50
40
30
20
10
0
EGYPT
PHILIPPINES
TOGO
SENEGAL
GHANA
BENIN
NIGERIA
PAKISTAN
SRI LANKA
CAMEROON
HAITI
KENYA
INDIA
THAILAND
ZAIRE
SIERRA LEONE
INDONESIA
20 kg/cap
MALAWI
UPPER VOLTA
MALI
NIGER
RUANDA
BURMA
CEMENT CONSUMPTION FORECASTS
FOR THE YEAR 2000, FOR NIGER
MALI AND UPPER VOLTA
100
300
400
NIGER, H. VOLTA, MALI
150 8/CAP in 2000
GNP per capita in US dollars 1974

Evaluations of these cement markets were based on the following considerations : (1)

- the Togo-Benin region can produce large amounts of cement especially through the CIMAO (West African cement) project, which will not only supply these two countries but also Ghana and the Ivory Coast where there does not seem to be any of the limestone needed for making cement.

- if the railway is not built, the Sahel cement factories will be limited to supplying only one local market and therefore will have to be medium in size. On the other hand, the cement factories in the Togo-Benin region will conquer the large coastal markets and be in a position to expand, and thus have lower cost prices than in the Sahel. The subsequent tendency will be for them to seek markets further inland.

  On the Abidjan-Ouagadougou route, for instance, the CIMAO clinkers, with low cost prices, transported under easy conditions between Lomé and Abidjan and then processed into cement in the factory at the Abidjan port will be, pricewise, very competitive with the Tin Hrassan cement and thus will compete for the Southern Upper Volta market.

  Using this hypothesis, part of the Malian, Voltaic and Niger cement markets will be supplied from factories located at the coast.

- if the railway is built the cement market served by the inland factories will feel the need as a result of large scale production and, in turn, will be able to reduce cost prices. If this hypothesis materializes the Northern part of the Ivory Coast will find it less expensive to buy cement from Mali and Upper Volta (2).

To be on the safe side we projected that 50,000 tons/year from Mali and the same amount from Upper Volta would be sold in the North of the Ivory Coast, which only satisfies 5 per cent of the Ivorian market in the year 2000.

Map 3 referring to the above hypothesis, sketches the development of cement production in West Africa in the year 2000.

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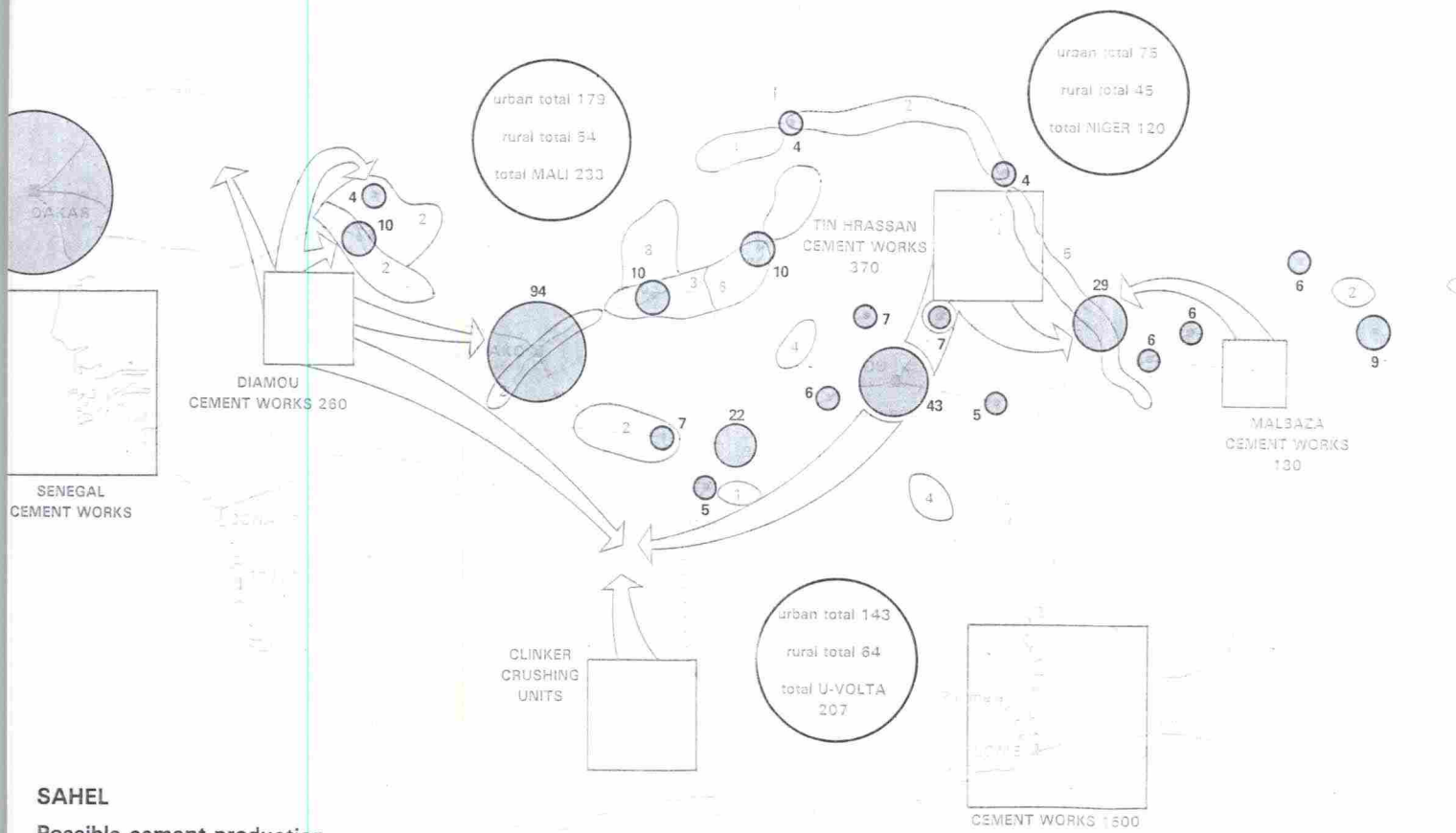
(1) It was assumed that whatever the plan (with or without a railway) all the industrial enterprises had a normal earning capacity.

(2) If the rates hypothesized in paragraph 2.3 are applied.



SAHEL

Possible cement production
and consumption scenario for the year 2000

- **cement consumption by the major cities in 1000 t.**
- cement consumption in the irrigated perimetres in 1000 t.

□ major cement works (annual capacity in 1000 t.)

MAP N° 3

CONCLUSION

We have seen that the existence of a trans-Sahelian railway will have a considerable effect on the structure of the cement industry in the region.

If the line is not built the coastal cement factories in Senegal, Togo and Benin will conquer most of the Sahelian cement markets conveying their goods on the good quality roads running inland. This would stunt the growth of the Sahelian cement works whose only outlet would be the local markets.

A railway is made to transport heavy, low value goods, so can move them further which means factories enjoy a broader market, thus produce more and consequently cut their cost prices. The attractive prices alone will suffice to trigger development and the expansion of the market.

Countries where little cement is consumed in huge spaces can use the trans-Sahelian railway to help create and develop a bona fide cement industry to supply the inland markets, and, very probably, extend activities to neighbouring countries lacking in the limestone needed to make cement, and also stimulate cement consumption there before severely restricted by high prices.

Even if the figures on Map 3 must be read with caution and even if it is difficult to accurately evaluate which percentage of the market is served from the inland and from the coastal cement works respectively in the year 2000 (production and transport costs can vary sharply so it would be risky to use the quantitative approach) we can see what effects a trans-Sahelian railway could have in structuring the development of a key industry.

4.2 - FERTILIZERS (MAP 4)

The FAO study (1) estimates that 1 kg of fertilizing element is needed for every 8 to 9 kg of agricultural output.

The study estimates the 1990 needs to be :

- . 70,000 tons of fertilizing elements for Mali
- . 64,000 tons of fertilizing elements for Upper Volta
- . 35,000 tons of fertilizing elements for Niger

If the agricultural production increases are 4 per cent, 3 per cent and 2 per cent for Mali, Upper Volta and Niger respectively, in the year 2000 the needs will amount to :

- . 105,000 tons of fertilizing elements for Mali
- . 86,000 tons of fertilizing elements for Upper Volta
- . 43,000 tons of fertilizing elements for Niger

totalling 234,000 tons

According to FAO the fertilizing elements would be 45 per cent nitrogen (N), 35 per cent phosphorus (P) and 20 per cent potash (K), which means between 4 and 500,000 tons of fertilizer.

The CEAO (Economic Community of West Africa) had SEMA make a study that provides data for 1995 as follows :

- Upper Volta

  - . 130,000 tons of a 18-35-0 mixture
  - . 65,000 tons of urea

  totalling 195,000 tons

- Niger

  - . 150,000 tons of a 15-15-15 mixture
  - . 30,000 tons of single super phosphate
  - . 5,000 tons of triple super phosphate

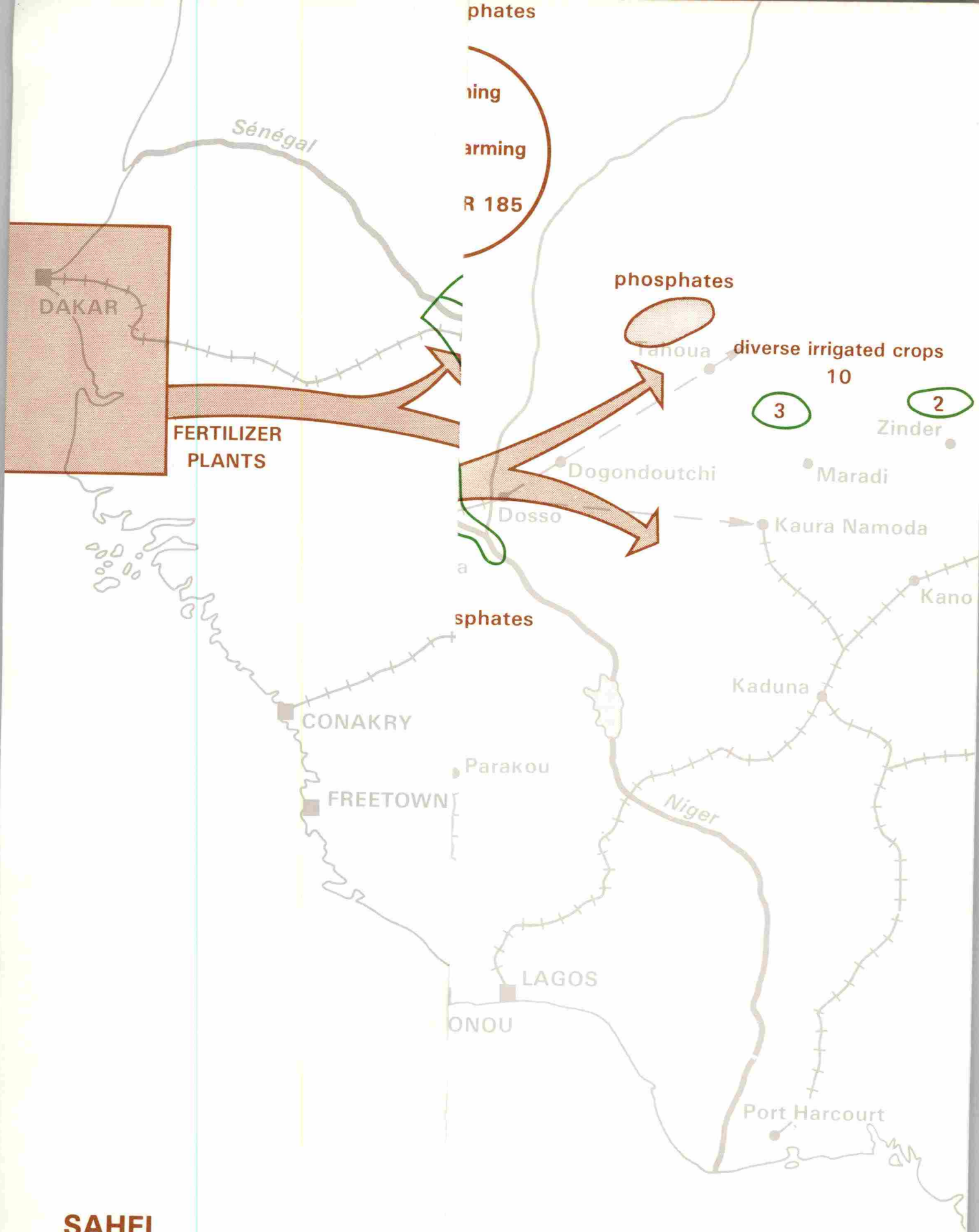
  totalling 185,000 tons

- Mali

  - . 110,000 tons of urea
  - . 130,000 tons of ammonium phosphate
  - . 40,000 tons of single super phosphate
  - . 20,000 tons of other nutrients

  totalling 300,000 tons

(1) see bibliography at the end of this study.



SAHEL

Possible fertilizer productio and consumption scenario

- **figures in 1000 t/year**

MAP N° 4

So for the three countries this would mean :

. 175,000 tons of urea
. 130,000 tons of ammonium phosphate
. 5,000 tons of triple super phosphate
. 70,000 tons of single super phosphate
. 150,000 tons of 15-15-15 mixture
. 130,000 tons of 18-35-0 mixture
. 20,000 tons of other nutrients

totalling 680,000 tons

The SCET-SEDES perspective study predicts the consumption level to waver around a million tons of fertilizer for the six countries (Senegal, Mauritania, Mali, Upper Volta, Niger and Chad), half for irrigated crops and half for rainfed crops.

The study quantitates consumption in the central countries, i.e. Mali, Upper Volta and Niger as follows : fertilizer will be applied to half the irrigated crops and two-thirds of the rainfed crops (scenarios 1 and 3).

The study expects Mali, Upper Volta and Niger to absorb a total of 580,000 tons of fertilizer.

How to satisfy such large demands ?

A goodly part of the fertilizer comes from nitrogen-rich elements, drawn at present mainly from regional deposits in Senegal and Togo. Since Mali, Upper Volta and Niger also contain large phosphate deposits, a third source, in the W du Niger region, might be exploited and could compete with Togo and Senegal for the Upper Volta, Niger, Mali and North Ivory Coast markets.

With this in mind we developed the following hypothesis :

- in the year 2000 West Africa could receive its fertilizer compounds from two huge installations in Dakar and Abidjan. The Dakar factory would use local phosphates and make ammonia using imported naphtha and whatever imported potassium it needs. In any case the factory would supply Senegal and West Mali. The Abidjan factory would use Togolese phosphates, would probably make its own ammonia and would import the potassium it needs. A local market would be served from a third factory located in Togo.

- if a trans-Sahelian railway is built, we think that a fertilizer factory would be sited at W du Niger which geographically seems better located than the deposits in Mali and Niger. This factory would use local phosphates, produce its ammonia using products from the oil refinery in the region (see paragraph 4.3 below) and would import potassium as needed.

Under this hypothesis phosphates from Niger and Mali could be used to produce crushed rock phosphates for local consumption.

This organizational plan for supplying fertilizers to West Africa is only one of many, but it is a very plausible one. But as the study on agricultural production factors in the CEAO states says, a comprehensive study for a master plan on the fertilizer industry in West Africa still needs to be carried out.

Using this hypothesis, the market for a fertilizer plant in the W du Niger region could be about 700,000 tons annually by the year 2000, (60 per cent would be phosphatic fertilizer). We have subtracted one-third of the Malian market which could be supplied by Senegal and added a 100,000 ton market in North Ivory Coast to meet half the area's fertilizer needs for food crops (excluding sugar).

It is not within the purview of our study to study the allocation of various types of fertilizer. The following table shows the production line for the principal fertilizers and gives a general idea of the inputs at the factory level and the possible scale of production to see whether it would be reasonable to measure these inputs, especially gaseous ammonia and urea.

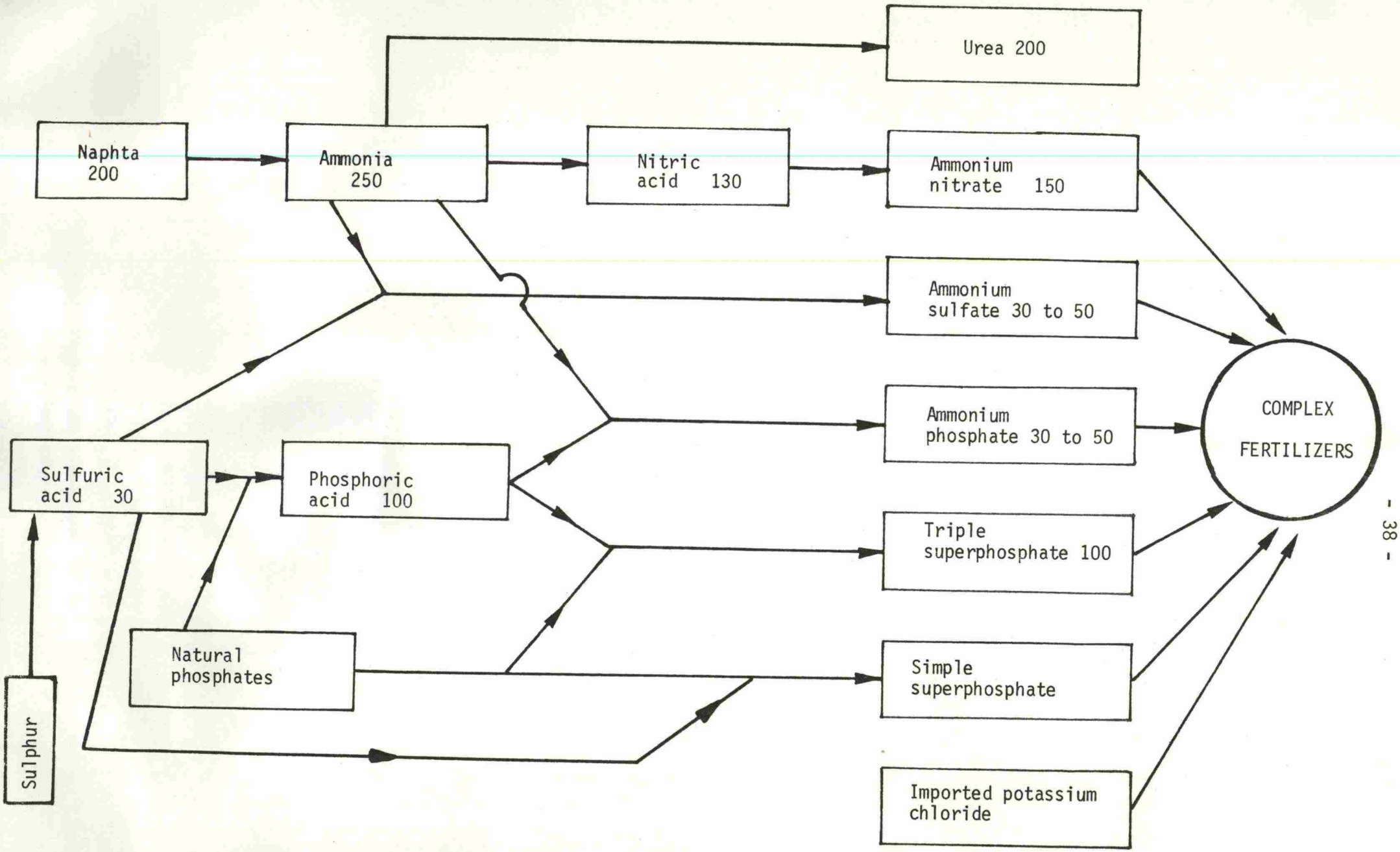
To study the distribution per area we have matched the consumption of fertilizers with the crop production depicted in Map 2.

On irrigated crops, 100-250 kg of manure per hectare corresponds to 50 kg of fertilizers per ton of cereal production.

For rainfed (or dryland) crops, the norm is 50 kg of fertilizer per ton of cereal production and 100 kg of fertilizer per ton of cotton or groundnuts.

These hypotheses are eco-statistical averages and not "agricultural facts". They seem rather conservative, which is understandable since the average income is estimated at $ 150 per capita.

The production and consumption of fertilizer in West Africa is sketched out in Map 4.



The figures in the boxes show reasonable minimum production units capacities (in 1,000 ton/year).

Compared with the Abidjan plant the W du Niger plant will suffer from a higher initial investment cost and very probably higher production costs for ammonia but, on the other hand, can obtain phosphate nearby. The iso-price line falls in the North of Ivory Coast, which explains why it is very reasonable to expect sales of 100,000 tons of fertilizer per annum in this region.

CONCLUSION

If the trans-Sahelian railway is not built, it is highly probable that the phosphate deposit at W du Niger will meet local needs and be exported, by rail, to the coast. the neighbouring markets will undoubtedly be too narrow to justify the construction of a large factory for fertilizer compounds.

Here again we see the role that the trans-Sahelian railway could play in structuring industrial development. If the link is not built, the fertilizer industry will tend to concentrate on the coastal markets near the phosphate deposits (Dakar, Lomé) or in large-consumption areas such as Abidjan.

The inland phosphate deposits will be tapped for export, if they are not too far from the ports, thus building up a modest industry, producing crushed phosphate rock or single super-phosphate to meet local needs.

This follows logically if the transport system is composed of links running from the coast inland.

Alternatively, a trans-Sahelian link will make it possible to develop a large factory which - and this is our working hypothesis - we suggested be sited at W du Niger.

We may question whether the Sahelian states' ambitious agricultural programme, which includes the use of greatly increased quantities of fertilizer, could be implemented without industrial scale production and consumption of Sahelian phosphates and the distribution thereof through an East-West communications line. Might not the importation of massive quantities of fertilizer create difficult problems of spatial distribution and balance of trade ?

4.3 - HYDROCARBONS IN THE YEAR 2000 (MAP 5)

Consumption curves relating to several other countries tend to indicate that the hydrocarbon consumption level in a country with an annual per capita income of $ 150 should be approximately :

- 27.0 kg/capita/year for gasoline and diesel oil
- 4.5 kg/capita/year for petroleum and liquefied gas
- 12.0 kg/capita/year for heavy fuels

(see following chart).

Final uses of hydrocarbons have been sketched in the next table. One of the main final purposes is heating for industry, especially for thermal power plants producing electricity. Total consumption figures therefore depend largely on the amount of hydraulic power produced.

Assuming that the trans-Sahelian railway is constructed we worked out feasible consumption levels and spatial distribution of hydrocarbons in Niger, Upper Volta and Mali (Senegal, whatever be the case, will be supplied from the refinery (ies) in the Dakar region). This plan considers the cement and fertilizer industries to develop according to the pattern indicated in the preceding paragraphs.

It is only of indicative value because of the uncertainties of implementing an electricity inter-linkage programme, hydro-electric development schemes and the effects of new sources of energy between now and the year 2000.

Heavy fuels

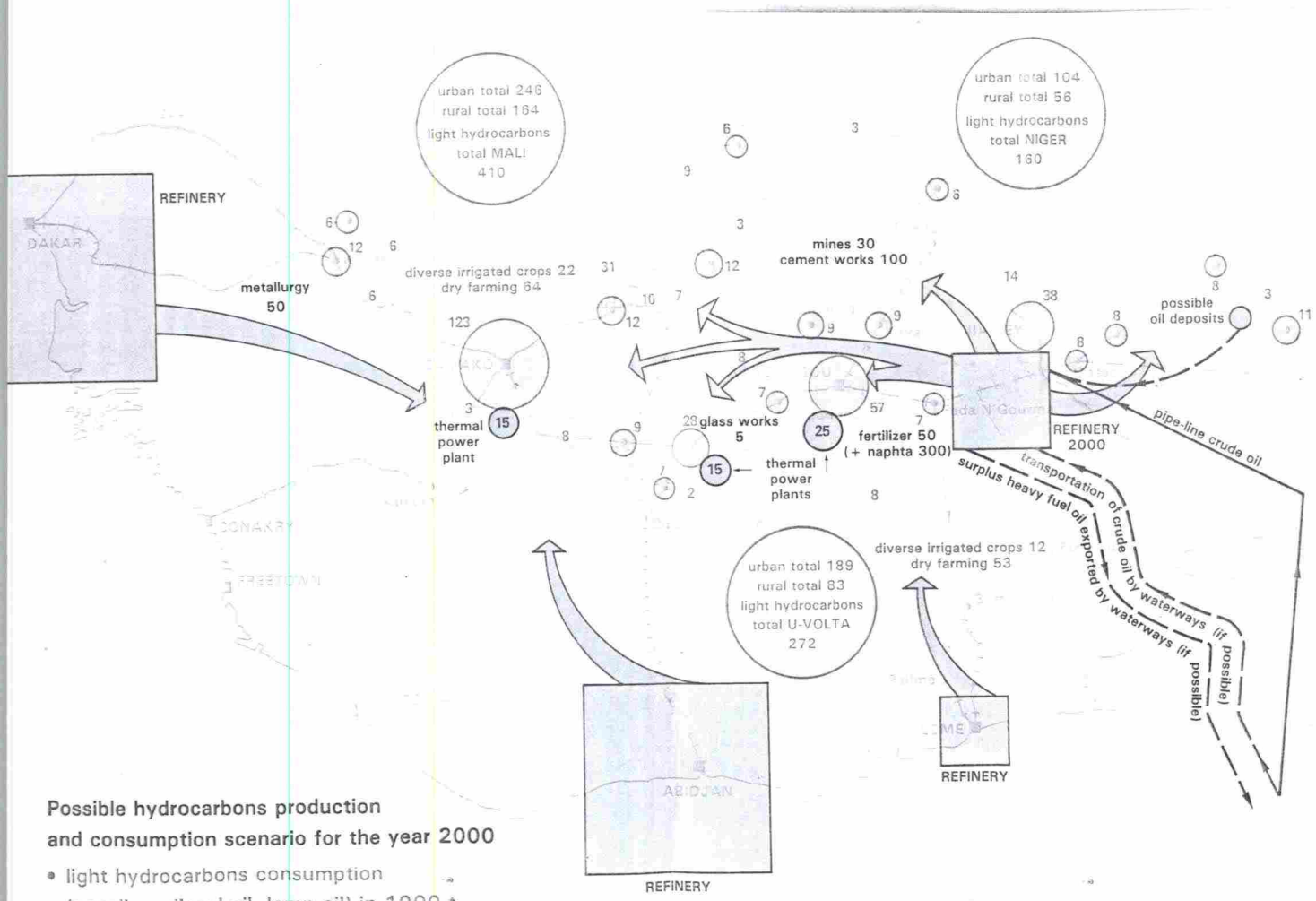
The scheduled hydraulic power programme is so vast that the fuel requirements, thanks to the global approach, might be held down under 340,000 tons. A more individualized evaluation gives us the following figures :

- manganese mines

  . assuming that half of the needs will be satisfied by using thermal power, about 30,000 tons of heavy fuels will be needed ;

- cement

  . to produce some 500,000 tons of cement will require approximately 100,000 tons of heavy fuels (200 kg of fuel for each ton of cement produced) ;

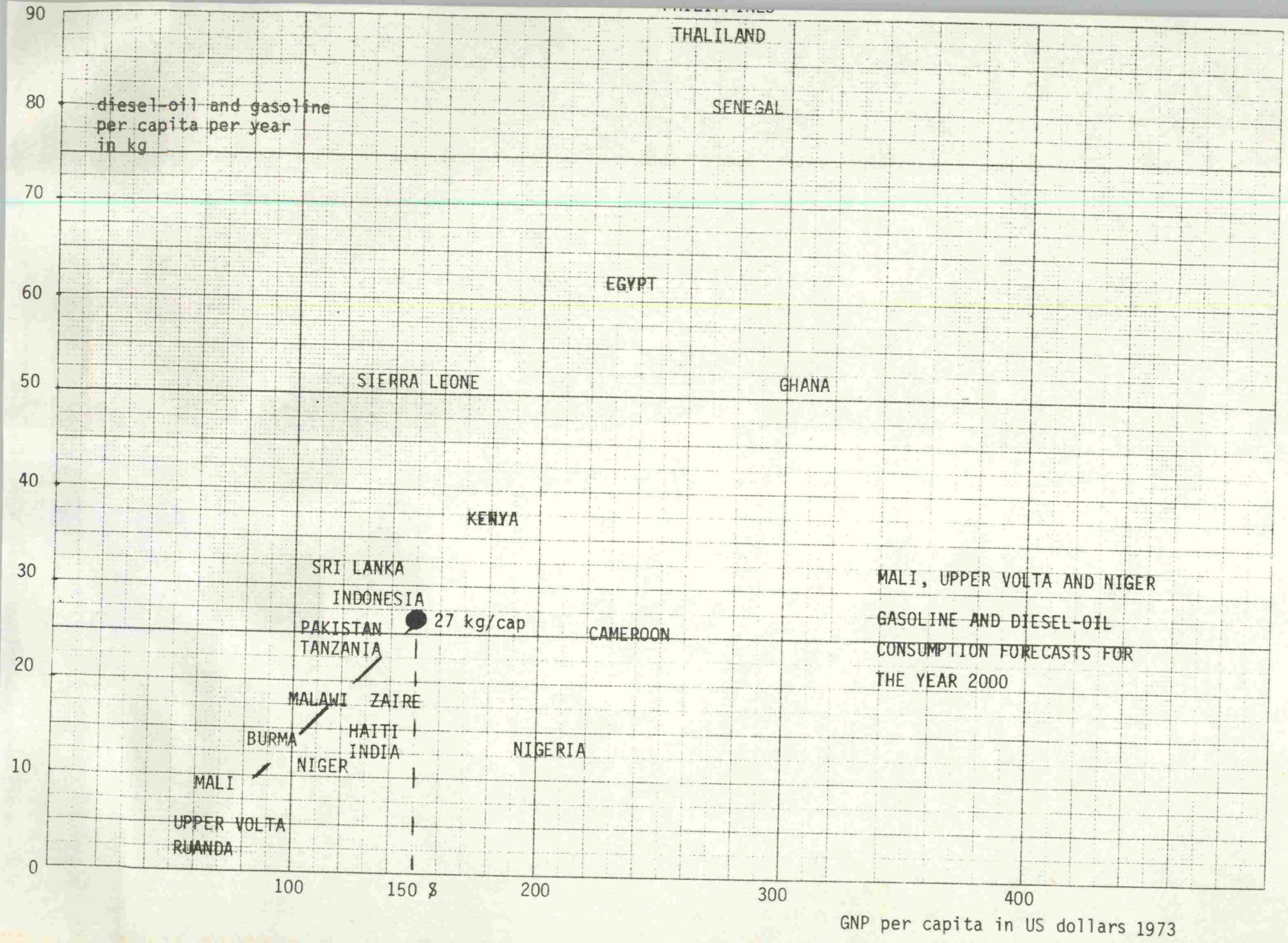


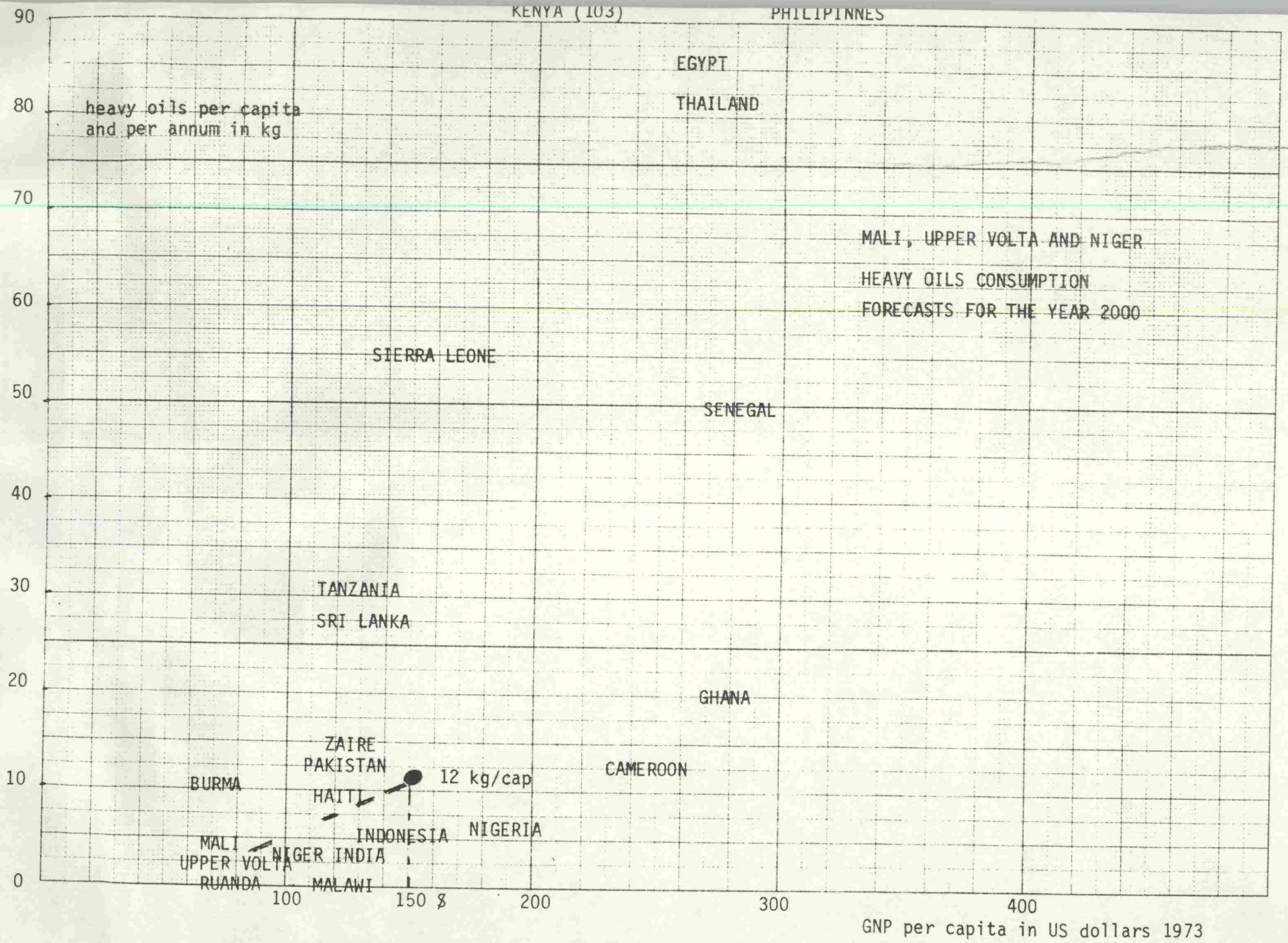
Possible hydrocarbons production and consumption scenario for the year 2000

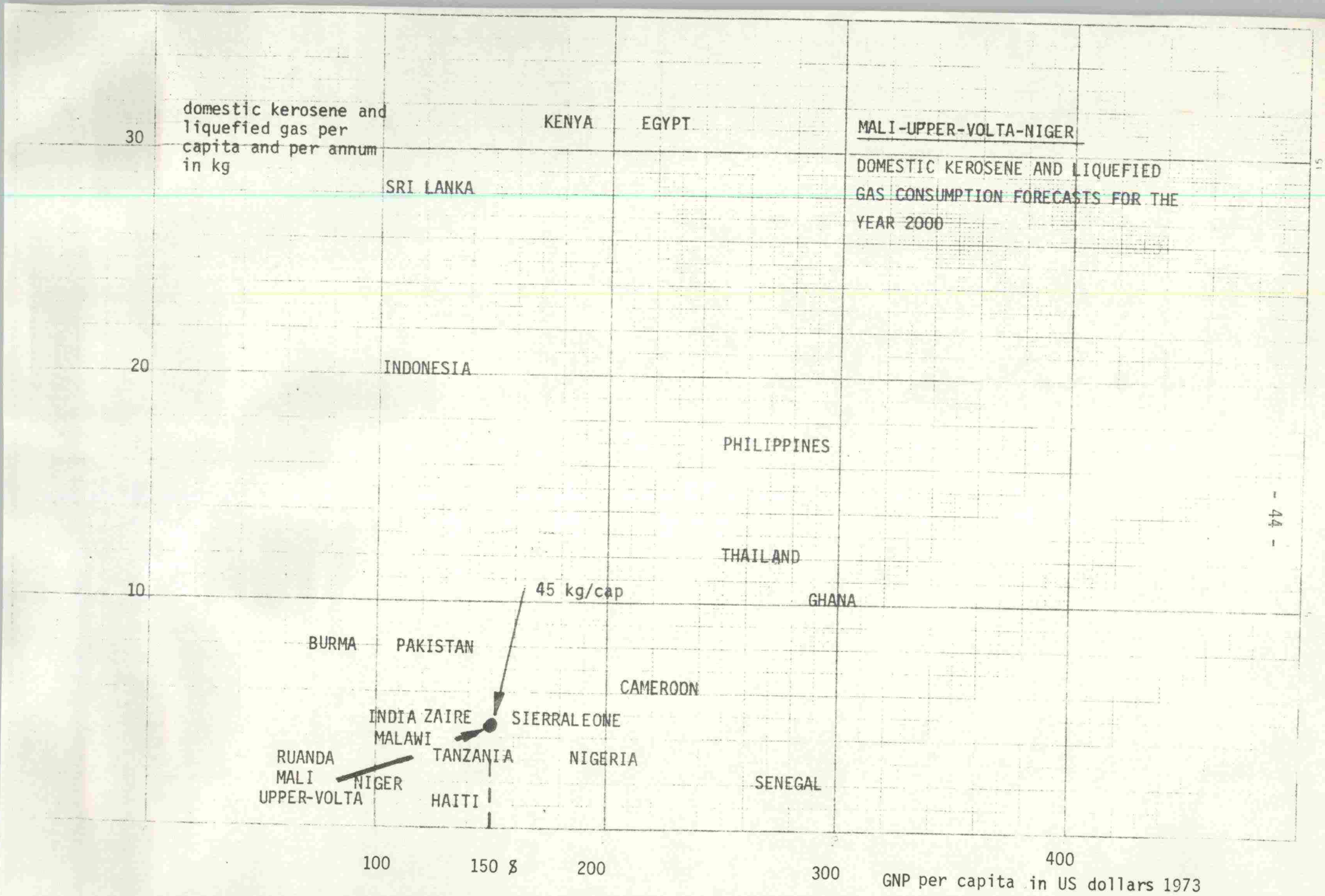
- light hydrocarbons consumption (gasoline, diesel oil, lamp oil) in 1000 t.
- heavy fuel oil consumption in 1000 t.

refineries (annual capacities in 1000 t.)

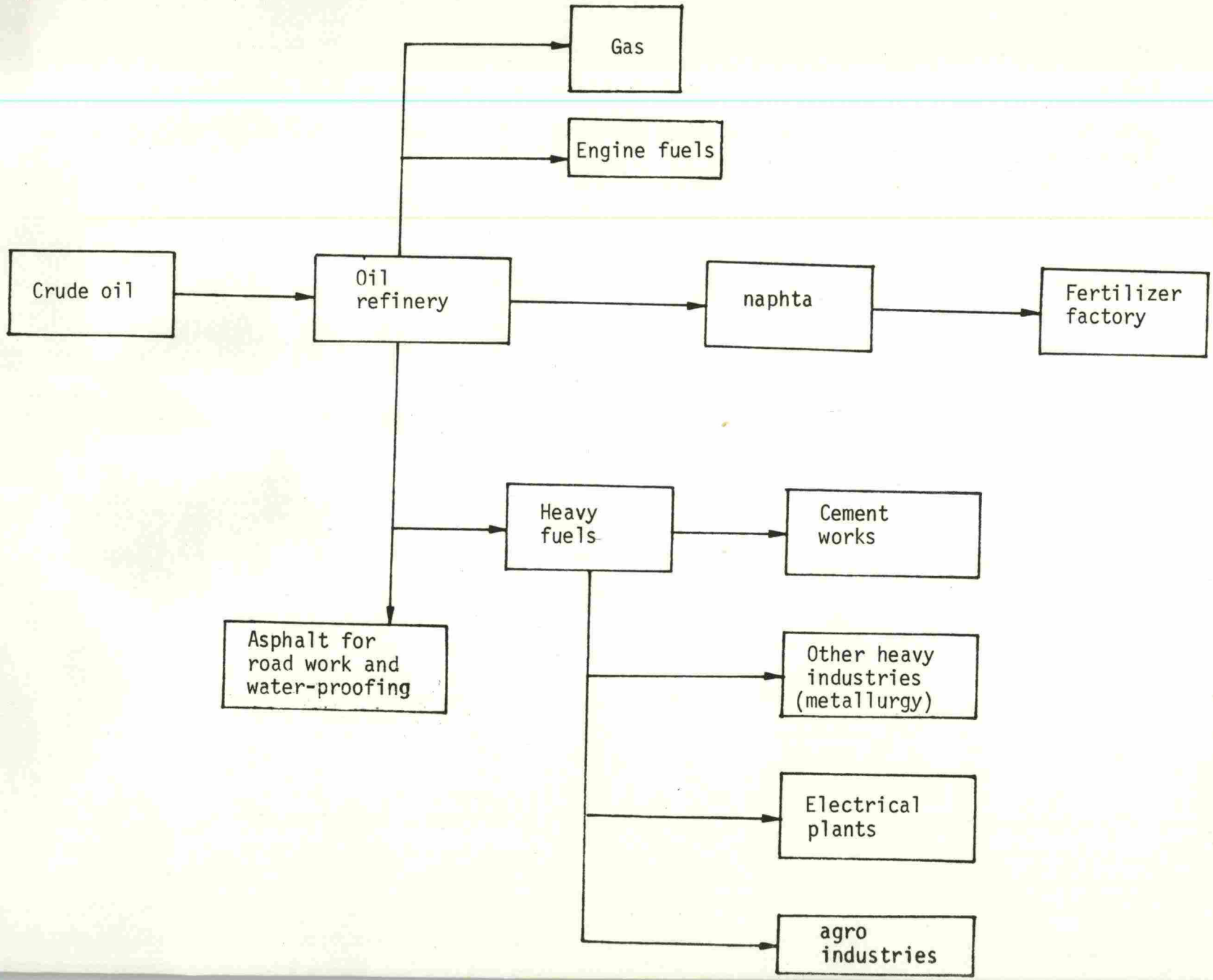
MAP N°


diesel-oil and gasoline per capita per year in kg
90
80
70
60
50
40
30
20
10
0
100
150
200
300
400
GNP per capita in US dollars 1973
THALILAND
SENEGAL
EGYPT
SIERRA LEONE
GHANA
KENYA
SRI LANKA
INDONESIA
27 kg/cap
PAKISTAN
TANZANIA
CAMEROON
MALAWI
ZAIRE
HAITI
BURMA
INDIA
NIGERIA
NIGER
MALI
UPPER VOLTA
RUANDA
MALI, UPPER VOLTA AND NIGER
GASOLINE AND DIESEL-OIL
CONSUMPTION FORECASTS FOR
THE YEAR 2000


KENYA (103)
PHILIPINNES
EGYPT
THAILAND
heavy oils per capita
and per annum in kg
MALI, UPPER VOLTA AND NIGER
HEAVY OILS CONSUMPTION
FORECASTS FOR THE YEAR 2000
SIERRA LEONE
SENEGAL
TANZANIA
SRI LANKA
GHANA
ZAIRE
PAKISTAN
BURMA
HAITI
12 kg/cap
CAMEROON
INDONESIA
NIGERIA
MALI
NIGER
INDIA
UPPER VOLTA
RUANDA
MALAWI
90
80
70
60
50
40
30
20
10
0
100
150 $
200
300
400
GNP per capita in US dollars 1973


domestic kerosene and liquefied gas per capita and per annum in kg
30
20
10
KENYA
EGYPT
SRI LANKA
INDONESIA
PHILIPPINES
THAILAND
GHANA
45 kg/cap
BURMA
PAKISTAN
CAMEROON
INDIA
ZAIRE
SIERRALEONE
MALAWI
RUANDA
TANZANIA
NIGERIA
MALI
NIGER
SENEGAL
UPPER-VOLTA
HAITI
100
150 $
200
300
400
GNP per capita in US dollars 1973
MALI-UPPER-VOLTA-NIGER
DOMESTIC KEROSENE AND LIQUEFIED GAS CONSUMPTION FORECASTS FOR THE YEAR 2000

REFINERY PRODUCT UTILIZATION



- fertilizer factory

  . to produce 700,000 tons of fertilizer will require an estimated 50,000 tons of heavy fuel per year for heating plus about 300,000 tons of naphtha to make ammonia ;

- electric power plant

  . for the Bamako, Bobo-Dioulasso and Ouagadougou power plants we estimate fuels needs to be 15,000, 15,000 and 25,000 tons per year respectively, considering the electricity produced by hydraulic energy ;

- other needs

  . iron and steel works (50,000 tons of fuel)

  . glassworks (5,000 tons of fuel), possibly brick-making (30,000 tons) and sugar production (10,000 tons) if bagasse is used as fibre (panels) rather than as fuel. Thus the total needs amount to about 330,000 tons, not far from the figure obtained using the global approach.

Diesel oils and gasoline are mainly used for transport, agriculture and small-scale industry.

The global approach to consumption of these products in the three states gives a total of 760,000 tons as follows : (in 1,000 tons)

- 63 kg of fuel for each ton produced through irrigated cropping
  Mali 100, Upper Volta 30, Niger 18 - Total 148

- 30 kg of fuel for each ton produced through rainfed cropping
  Mali 64, Upper Volta 53, Niger 38 - Total 155

- 82 kg of fuel per person per year for urban populations (industry, construction, tertiary sector, households)
  Mali 204, Upper Volta 164, Niger 89 - Total 457.

Concerning lamp oil and liquefied gas, we assume that these products for the three states, and half the output is allocated to towns, the other half to rural areas, consumption rates will be :

- towns 11,5 kg/capita/year

- countryside 2,8 kg/capita/year.

If we assume that 15 per cent of the urban consumption will come from liquefied gas we may assume the following :

- urban consumption : 11,5 kg/capita/year

  i.e. LPG 1,7 kg/capita
  lamp oil 9,8 kg/capita

The total urban consumption of light hydrocarbons thus would be 82 + 11,5 = 93,5 kg/capita/year as shown in Map 5 with the consumption of products for irrigated cropping, on Map 5.

The total hydrocarbon needs amount to :

- 300,000 tons of heavy fuel, mainly in Niger and Upper Volta ;
- 300,000 tons of naphtha in Niger ;
- 760,000 tons of light products as follows : 410 in Mali, 272 in Upper Volta and 160 in Niger.

A 2,000,000 ton capacity refinery could meet these needs and the need for asphalt, fuels, etc. Were it located in W du Niger it might be supplied from Niger deposits, by river transport (the Niger River) or by using a pipeline similar to the one in Zambia (6 inches), fed at Kaduna from the Port Harcourt to Kano pipeline in Nigeria.

It would be able to meet all needs for light fuels in Niger and Upper Volta and two-thirds of the Malian market needs, (the other third to come from Senegalese refineries). For the other products it could satisfy the full needs of these three countries.

CONCLUSION

As for cement and fertilizers, the railway would make it possible to satisfy the energy requirements of the three states, using a joint road and rail distribution network and regional deposits.

It also will open the door to a large capacity refinery to complement potential production from other refineries in the region.

In the absence of a railway, nothing more than a combination of small local refineries and imports could be envisaged.

The problem of re-exporting surplus heavy fuels has not been solved. If the Niger were navigable, it could be done by river transport ; otherwise it will have to be done by rail.

REMARKS

We can see that the development plans for the cement, fertilizer and hydrocarbons industries are interconnected and together form a whole since the refinery feeds the cement works and the compound fertilizer plant. Quite obviously this industrial entity would not be viable without a railway to handle intersectoral trade and the distribution of the finished products.

4.4 - GLASSWARE (See Map 6)

4.4.1 - Present situation

Because of the need for economies of scale, in the West African countries, efforts will have to be limited to the glass container industry (especially bottles).

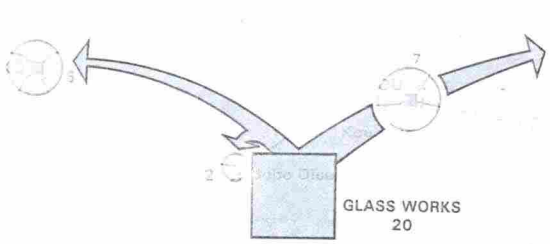
The 1975 production in the Sahelian states and Ivory Coast was as follows (Benin and Togo would be excluded in an inter-regional sales of inputs and outputs) :

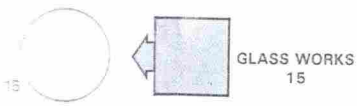
- Ivory Coast

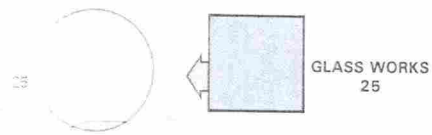
SOBOCI	250,000 hl	
SBB	100,000 hl	
BRACODI	500,000 hl	
SOLIBRA	600,000 hl	
	1,450,000 hl	

- Upper Volta

BRAVOLTA	200,000 hl	Ouagadougou
SOVOBRA	100,000 hl	Ouagadougou







SAHEL

Possible glass bottle production
and consumption scenario in the year 2000
• production in 1000 t.

MAP N° 6

- Niger

BRANIGER	80,000 hl Niamey
MARADI	35,000 hl Maradi

- Mali

SOMALIBO	20,000 hl Bamako
FAMABO	45,000 hl Bamako

Total Upper Volta, Niger and Mali 480,000 hl.

- Senegal

SOBOA	500,000 hl Dakar
SIBRAS	180,000 hl Dakar
	680,000 hl

At present there are no glassware factories in these countries. A project that was promoted by BGI, and Saint Gobain (Container Division) and others since 1970 has not yet materialized.

It will undoubtedly be started soon, at least at the size now recommended (17,000 tons/year). This would meet 80 per cent of the present Ivorian need and half the needs of Niger, Upper Volta and Mali. The factory designed to produce the standard returnable bottles ; because of habits and the recovery system no-deposit bottles will not be introduced for many years and cannot be included in this study.

4.4.2 - Consumption in the year 2000

- Ivory Coast

For the year 2000, for convenience sake let us consider the area North of the Daloa-Yamoussoukro line (the woody savannah) as an "independent" production-cum-consumption zone, and wage it against the Southern zone (coasts and forests) centring on Abidjan.

For the former, the consumption is estimated at 1,200,000 hl with production points at Bouaké, Bouaflé and Daloa.

For the second zone, the consumption is estimated at 2,200,000 hl with production mainly in Abidjan and possibly at San Pedro.

- Mali, Upper Volta, Niger

Beverage production points will be much further apart, i.e. Bamako, Ouagadougou, Niamey, Maradi and maybe Kayes.

It might be estimated at 1,500,000 hl in the year 2000.

4.4.3 - Possible scenarios

. Without a Sahelian railway

The market of each of the Ivorian zones is big enough to justify establishing a glassware factory, transport costs being low since the breweries are nearby.

A glassware factory might also be considered for Senegal even if future breweries are to be built inland. The Dakar-Bamako railway would help to keep the Senegalese glass market united.

The Mali, Upper Volta, Niger breweries would cover a market extending over more than 1,500 km. If a bottle factory was well located near these breweries, could the market be conquered ? Senegalese and Ivorian bottle plants, thanks to marginal production costs and rail transport, can supply the breweries in these countries at a substantially lower price.

The Mali, Upper Volta, Niger market is still disconnected with supplies coming from the coast. This being the case we might plan e.g.

- a glassware factory at Dakar : 30,000 tons/year
- a glassware factory at Abidjan : 35,000 tons/year
- a glassware factory at Bouaké : 20,000 tons/year

. With a Sahelian railway

There would be no change in bottle supplies for breweries in Ivory Coast and Senegal.

The Mali, Upper Volta and Niger markets would be regrouped thanks to the Sahelian railway. A bottle factory located, for instance, between Bougouni (Mali) and Ouagadougou (Upper Volta) could offer breweries economic conditions at least equal to those offered by competitors from Senegal or North Ivory Coast.

Bottle factory sites and capacities for this scenario are presented on Map 6.

CONCLUSION

We have studied the glassware example in rather great detail although it might only make a small contribution to traffic on the trans-Sahelian railway. It seems to serve as a representative case.

- If the trans-Sahelian railway is not built, industrialization will be started at the coast. The newly created industries will then use the roads leading towards the interior to supply the inland markets. Each of these - isolated- markets will want to build its own factory, a joint venture being impossible without adequate means of transport. As the economies develop, industrialization will spread inland (Bouaké) but it will take very considerable time for it to reach the Sahelian countries (after 1977-2000 time period for this sector). Their industrialization will be even more retarded by the large size of the coastal industries and the resulting economies of scale.

  The unsuitable structure of the transport network holds back industrialization in the landlocked countries.

- On the other hand, were a Sahelian railway built, it would bring together the markets needed for such industrialization.

4.5 - AGRICULTURAL EQUIPMENT

The irrigated and dryland crops programme for the Sahelian countries will call for greater production of certain agricultural equipment.

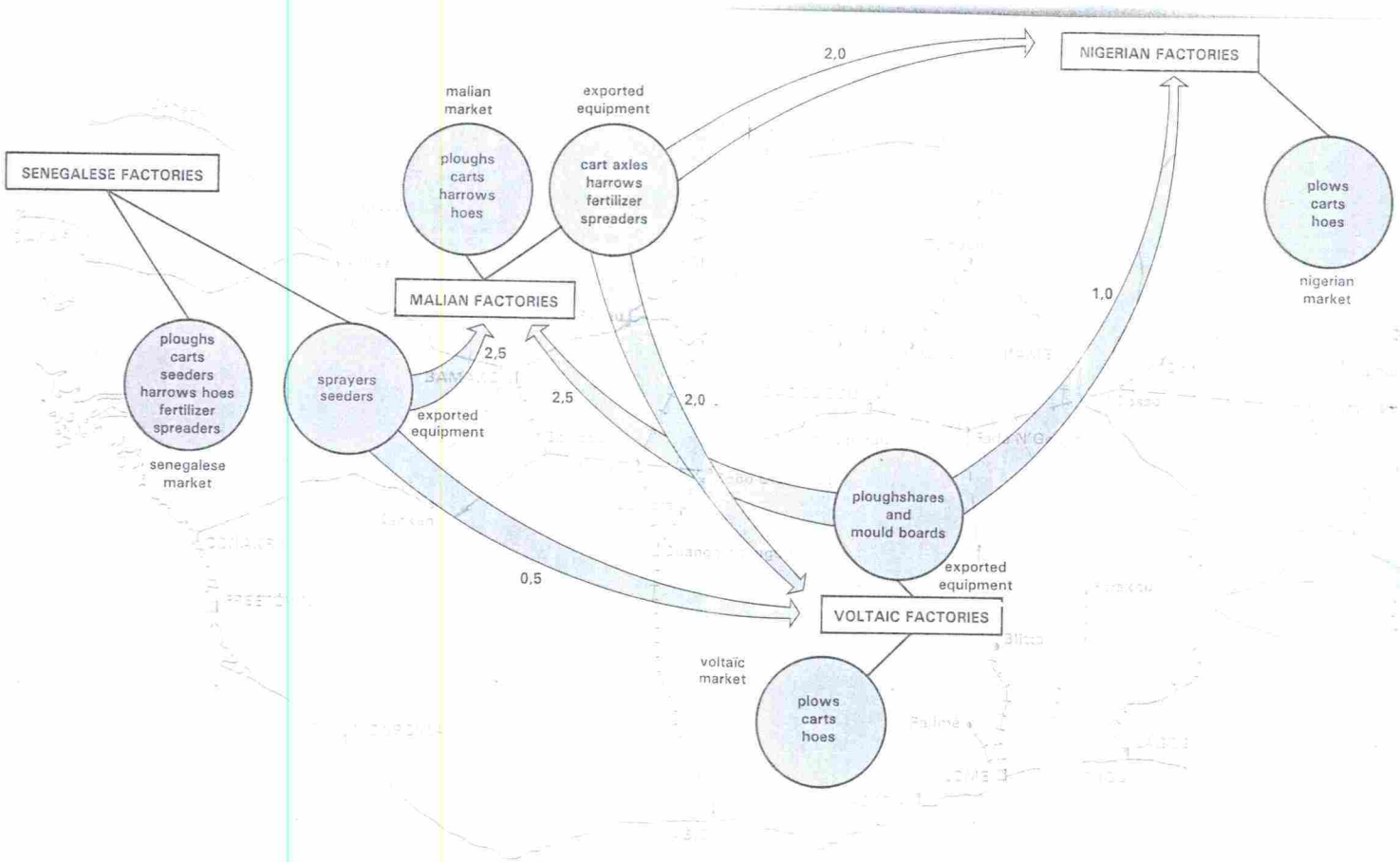
Except in Senegal, in the year 2000, agriculture will still largely use animal traction although irrigated farming programmes will, in certain cases, promote mechanization.

In the year 2000 agricultural equipment for local and regional production can be estimated as follows :

sales per year

	Niger	Upper Volta	Mali	Senegal
Toolbars Ploughs Hoes	25,000	25,000	50,000	100,000
Harrows	3,000	3,000	6,000	10,000
Carts	10,000	10,000	25,000	40,000
Seeders	3,000	1,000	5,000	50,000
Spreaders	5,000	5,000	10,000	40,000
Sprayers	15,000	15,000	25,000	50,000

These figures present a possible hypothesis and have been calculated using the CEAO (Economic Community of West Africa) study on factors of agricultural production. They have been updated to cover both a more distant horizon in time and a conceivably more ambitious agricultural development programme.



SAHEL

Possible agricultural equipment exchange scenario in the year 2000 - figures in 1000 t.

MAP N° 7

Most of these items will be manufactured in the Sahelian countries individually. The following are the only items which, thanks to large economies of scale, may be produced at the regional level.

Item	Place of production	Exported to...
Ploughshares and mould-boards	Upper Volta	Niger, Mali
Cart axles, Harrows spreaders	Mali	Upper Volta
Sprayers, seeders	Senegal	Mali, Upper Volta

This is only an example and is based on market possibilities (size, mechanization).

A Sahelian railway is a pre-condition to regionalizing production because of both transport costs and reliability of supply.

Map 7 details the traffic flow.

4.6 - SALT

The new saltworks in Sine Saloum have a capacity of 180,000 tons of which 80 per cent is exported to Europe.

The potential demand for cooking salts in the landlocked countries of the Sahel and North Ivory Coast has not been developed because of transport charges. For climatic and geographic reasons, there are no plans to construct other production units outside the Kaolack region by the year 2000 in the Sahel or in Ivory Coast.

A Sahelian railway would considerably decrease the cost of salt in Upper Volta, Niger and in North Ivory Coast. A very conservative hypothesis would be that each person would consume 10 kg of salt, brought in by rail, per year.

Let us assume that this added consumption in the above-mentioned countries affects 20 million inhabitants. This means that the additional traffic would be 200,000 tons per year from the Kaolack saltworks ; it would be made possible by the existence of the rail line.

The traffic flow in detail :

- Kaolack - Bobo Dioulasso	:	40,000 tons
- Kaolack - Ouagadougou	:	40,000 tons
- Kaolack - Niamey	:	60,000 tons
- Kaolack - Ferkessedougou	:	60,000 tons
		200,000 tons

4.7 - MOLASSES

The sugar development programme for the Sahelian countries will produce large quantities of molasses which are of greatest use in livestock feed.

It seems reasonable to presume that molasses will be processed and consumed locally in Mali and in Upper Volta. If Ivory Coast lives up to its target production of 500,000 tons of sugar, and thus produces 150,000 tons of molasses it will have a surplus which at first view can be estimated at around 75,000 tons.

There are two possible solutions :

- export to the world market at international prices (175 FF/T FOB in 1977) ;
- export to Sahelian countries, especially Niger.

Exporting such large quantities to Niger would require access to a rail line. The molasses could then be processed in an independent plant and distributed for sale to intensive livestock production units.

By processing we mainly mean mixing it with other products such as groundnut shells, cotton by-products (at a proportion of 20-80 per cent) and then conditioning it.

Since the molasses upgrades the plant by-products mentioned above by making them more palatable we estimate value added through processing to be around 20 per cent of the value of the molasses sold at Niamey.

4.8 - BITUMEN

A refinery with a production capacity of two million tons per annum has been sited in the W du Niger region for the year 2000.

This refinery will produce a minimum of heavy asphalt residue to be upgraded in a bitumen plant.

The capacity of the bitumen plant could be some 60,000 tons per annum (3 per cent residue).

It would supply Niger, Upper Volta and Benin. Competition from Abidjan (250,000 tons/year) and Dakar would rule out the Ivorian and Malian markets.

The premise is that it would only be economic for 50 per cent (30,000 tons/year) of the output from the bitumen plant to be transported by rail (the W to Ouagadougou and W to Parakou lines).

CONCLUSIONS OF THE SECTORAL STUDIES

Quite clearly there are other sectors of industry that would be affected by the creation of a trans-Sahelian line. The sectors discussed above were chosen either because, a priori, they seemed designed to generate substantial traffic on this line or because the creation of the railroad would result in changes in their development pattern.

In the diagram we have adopted - which undoubtedly is not the only feasible one - the trans-Sahelian route seems to contribute to structuring industrial development somewhat as follows :

- at each end of the route there would be a pole for heavy industry including cement works, oil refineries, compound fertilizer plants, bitumen factories and perhaps other industries which we have not mentioned. The West end, the Dakar region, would be slated for development, whatever be the scenario ; but this is not applicable to the "Eastern pole" where development will depend on the construction of a trans-Sahelian line.

  Another pole may develop for the iron and steel industry and quite possibly other related industries, using iron ore from Falémé, bordering Senegal and Mali. The information we have concerning this is too incomplete and unprecise for us to be able to consider it in this study.

But if this complex materializes, the trans-Sahelian line to Mali, Niger, Upper Volta and the North of Ivory Coast will prop up the market and substantially increase the transport of finished and semi-finished metal goods.

Thanks to the gas from the refinery in the W region it may even be possible to create a small metal works factory using the iron ore from Say which at present cannot be exploited.

- A trans-Sahelian line might well stimulate the creation of processing industries in the centre of the zone (Upper Volta and Mali) with markets stretching across the three landlocked countries, as demonstrated by the glassware example.

This said, one point needs to be stressed : building a trans-Sahelian railway does not mean that a large number of new industries will spontaneously crop up. The railroad may be a condition sine qua non for new industrial expansion, but it is not enough. The creation of new industries is subordinated to the States' decisions concerning their economic policies, market openings, the free circulation of goods, the price of energy and labour.

In conclusion to these sectoral studies let us say that the present transport system in West Africa does not meet the needs of a satisfactory level of industrialization and, in particular, does not allow the landlocked countries to implement a freely-designed policy for the industrial part of their physical land development scheme since transport problems prevent them from effectively implementing their chosen plans. On the other hand, by creating an East-West line, as we have illustrated, it would become possible to carry out a more autonomous industrialization policy and allocate industries more satisfactorily along this East-West axis. The distribution plan we presented is unquestionably only one of many.

CHAPTER 5 - POSSIBLE TRAFFIC FLOWS ON THE TRANS-SAHELIAN LINE

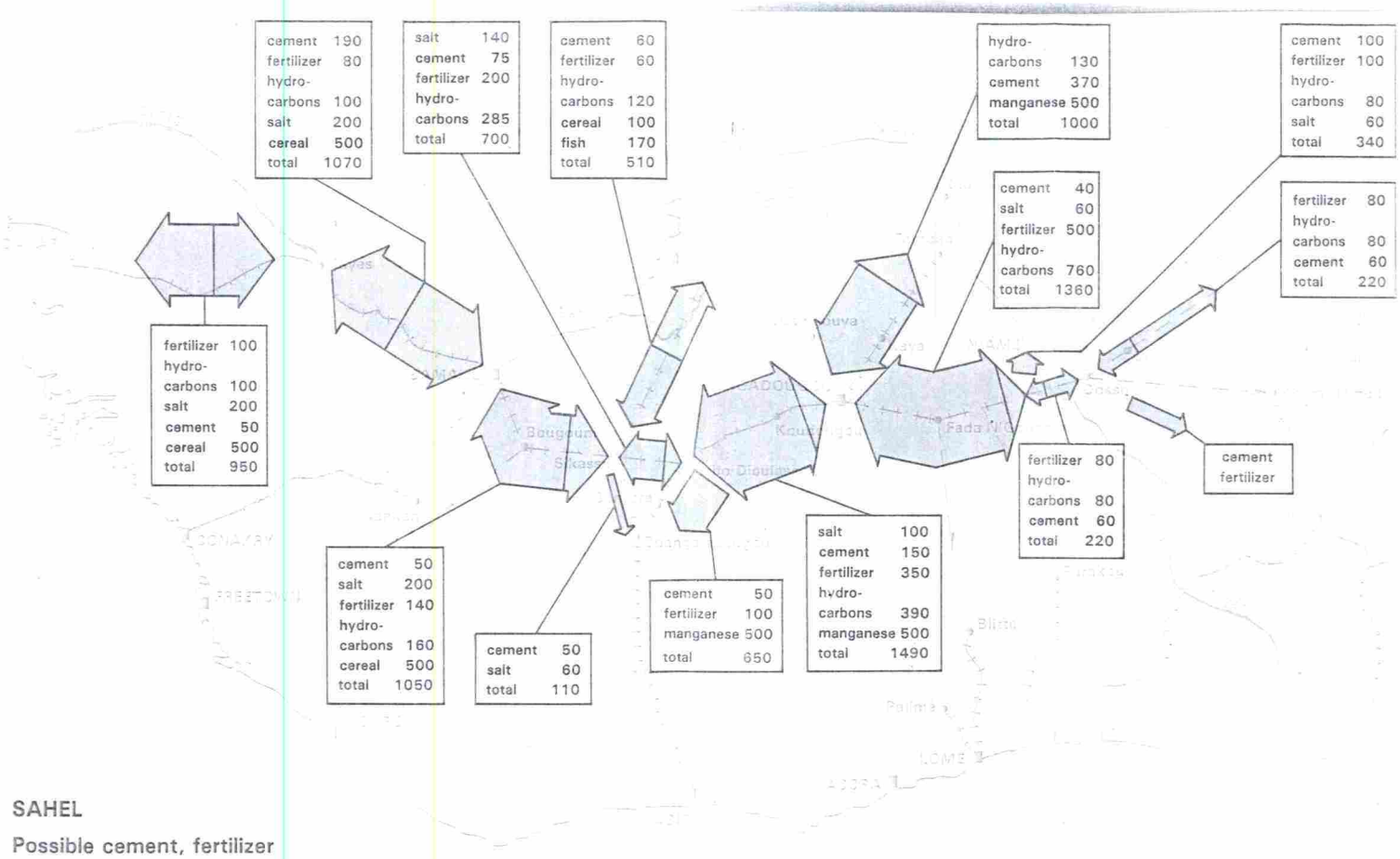
5.1 - SUMMARY OF FLOWS

Map 8 indicates the main flows itemized in the sectoral studies in the preceding chapter. It also shows the flow of agricultural, animal and fishery products reported in Sahel Club documents.

In all likelihood this is a cautious estimate of the possible traffic flows on the trans-Sahelian line around the year 2000 since,

- in the sectoral studies, very prudently only conservative figures were used ;
- other industrial sectors could generate substantial traffic ;
- local, intra-national traffic and large scale imports and exports which could be lucrative, were not included ;
- allowances have not been made for passenger traffic which is always sizeable in the Sahelian countries ;
- lastly, traffic estimates for agricultural, livestock and fishery products are not within the purview of this study so only received cursory attention. It should be stressed that in the - frequent - years of rainfall shortage in given areas of the Sahel, the trans-Sahelian line would play an important role bringing in cereals from normal rainfall areas to the deficit areas ; the traffic generated would admittedly be irregular, but it would be sizeable.

Even if certain studies of the industrial sector prove to be largely wrong ; which, because of the superficial character of the perspective study is possible, or even probable, and if the error is an overestimation of the traffic generated on the trans-Sahelian line, there are so many sources of potentially substantial traffic that have been omitted that traffic flows on Map 8 can be recognized as minimum orders of magnitude.



SAHEL

Possible cement, fertilizer and hydrocarbon generated rail traffic flows scenario for the year 2000

(with reference made to cereal, fish and mining)

Other traffic was not put on this map

MAP N° 8

5.2 - TRAFFIC FLOWS GENERATED BY THE CEMENT, FERTILIZER AND HYDROCARBON INDUSTRIES

These industries are vital to the economic, especially agricultural, development of the central areas of the Sahel and generate quantity traffic detailed by products in the annex.

Because of the geographical position of consumption points, factories, and the distribution pattern, transport for these three products is mainly East-West, especially between W du Niger and Ouagadougou (up to 1,300,000 tons per annum).

This traffic might appear rather unbalanced but we must not forget that there is much more traffic, nos just these three basic products.

We might start, however, by discussing the hypothesis on these three products which explains this flow structure.

Siting of consumption will not ve given further attention since this data only applies site-related prospects for the future.

Concerning the geographical siting of factories :

- the three cement factories are well underway or are already being constructed. We think they would have been located closer to the consumption centres if that had been possible. So there is no justification for resiting them, nor building more since even in the year 2000 it will be more advantageous to have fewer but larger factories ;

- the oil refinery has been sited in East-centre Sahel because of the nearness of Nigeria, a powerful oil producing country, promising oil prospection in Niger and the desire to develop river transport on the Niger.

  This choice is the result of our tendency to site this vital development structure in as central (that is, as unperipheral) a position as possible. Ideally it should be in the middle of the centre of the Sahel to minimize the heavy transport.

  Considering the present sources of crude oil two other possibilities could be considered :

  . a two million ton refinery at Kayes using river transport ;

  . a million ton refinery near Kayes and another one of the same size in W du Niger.

- It would be difficult to site the fertilizer plant anywhere but in W du Niger because of the proximity of the phosphate deposits.

The overall distribution plan is quite obviously largely based on access to a combined rail-and-road link. The system we adopted runs as follows :

- factory - rail transport - regional depot - road transport - utilization.

Some deliveries will obviously be transported by road straight from the factory, but we have not made allowances for this since we are still in the very preliminary phase of our study.

5.3 - OTHER FLOWS

5.3.1 - Other industries

The Sahel will be open to many small industries by the year 2000. The individual corresponding transport components will be small but the accumulated traffic, in tons or volume, will be substantial. As an example traffic from glassware factories dealt with in the appendix.

Special mention needs to be made of sea bay salt which will be transported in large quantities ; a detailed diagram of the flow is presented in the appendix and we referred to it in Map 8.

5.3.2 - Flows of agricultural and fishery products

We are assuming an annual flow of 170,000 tons of fish on the Mopti-Sikasso link. It is difficult to predict cereal flows because of the great variation resulting from the vagaries of climate and agriculture from one year to the next.

The SCET SEDES study, with its broad global approach, has been used to make a partial calculation of these flows. According to the cereal scenario the Western area will have a cereal shortage of between 250,000 and 1,000,000 tons, offset more or less by the centre area, especially Mali.

That is why the Sikasso-Bamako-Kayes and perhaps the Mopti-Sikasso links may be loaded with, let us say, an additional 500,000 tons of cereals, not counting deliveries to the main towns of the centre, e.g. Mopti, Bamako which we estimate at about 100,000 tons/year.

5.3.3 - Flows of products from the mines

Most of the flow will come from the manganese deposit at Tambao on the Tambao-Ouagadougou-Bobo Dioulasso-Abidjan line. The annual total transports could be around 500,000 tons.

If the Niger were navigable it would provide an alternative for evacuating these products.

Projects at Falémé could also give rise to considerable additional traffic.

5.4 - CONCLUSION

Transporting cement, fertilizer, hydrocarbons and salt will amount to a flow of goods in excess of a million tons per year, mainly on the East-West line and, according to our hypothesis, especially between W du Niger and Ouagadougou.

These traffic flows would be complemented by large-scale exporting and importing, the flow of agricultural and mining products, and output from other industries and local traffic.

If necessary the conditions outlined above could be re-equilibrated by varying the siting of industries, especially the oil refining industry.

Lastly, the East-West Sahelian route ensures a direct rail connection between the industrial poles in Senegal and Ivory Coast and the huge market of Nigeria. This possibility could lead to heavy traffic well worth studying.

CHAPTER 6 - AN APPROACH USING THE ECONOMIC VALUE OF THE TRANS-SAHELIAN LINE

6.1 - A METHODOLOGICAL APPROACH

Building the trans-Sahelian railroad is going to be a very costly undertaking. An effort must be made to roughly estimate the cost.

Therefore, bearing in mind the above mentioned hypothetical rates and the foreseeable operating costs, we tried to see whether the company(ies) running the trans-Sahelian line might be able to break even.

Since the rates used are the same as the rates applied by railroad companies now operating in West Africa and experience has proven that these companies usually manage to cover their operating costs bu do not earn enough to amortize the construction costs and related financial charges, the same will probably hold true for the new line. This is a rough calculation that needs to be checked.

We have tried to make an overall estimate of the benefits that the three countries concerned (Mali, Upper Volta and Niger) will derive from the construction of the trans-Sahelian line and weigh these benefits against the construction costs to see whether it is really in the interest of these countries to encourage this investment.

6.2 - COST OF BUILDING THE TRANS-SAHELIAN LINE

The average per kilometre cost has been evaluated at 80 million francs. This calculation is based on the ascertainable or estimated construction costs for projects now in progress or projects recently studied for West and Central Africa.

We have not used the cost of building the trans-Gabon railway in our comparison because it is a normal railway (and not metric) designed for heavy traffic (at least ten times the estimated traffic for the trans-Sahelian line) and is being built in a very difficult region. We have also omitted using the costs for rehabiliting the Congo-Ocean railway which is also located in a difficult region of forests, high humidity and mountains.

On the other hand, we have noted that rerouting the Douala-Edea line, through the very wet forests, according to SOFRERAIL, will cost 125 million CFA francs per kilometre.

The cost of building a railroad between Togo and Niger has been evaluated at 80 million CFA francs per kilometre (the OFERMAT study on the Lomé to Niger link via the East of Upper Volta). This route traverses rather varied, but not especially difficult, regions, and we believe that this cost estimate might be representative of the cost for the trans-Sahelian line in general.

The estimated cost for the Ouagadougou-Tambao railway is only 60 million CFA francs per kilometre, but it will be running through a flat, barren region with a minimum of problems. We therefore took this as the minimum costs, applicable to only some of the links in the trans-Sahelian line and estimate the average cost to be higher.

The following diagram indicates that a total of 2,200 kilometres of rail line will be built, not counting the Tambao line which is considered as already underway.

Thus a rough estimate of the construction cost might be somewhere around 175 billion CFA francs at the 1976 value.

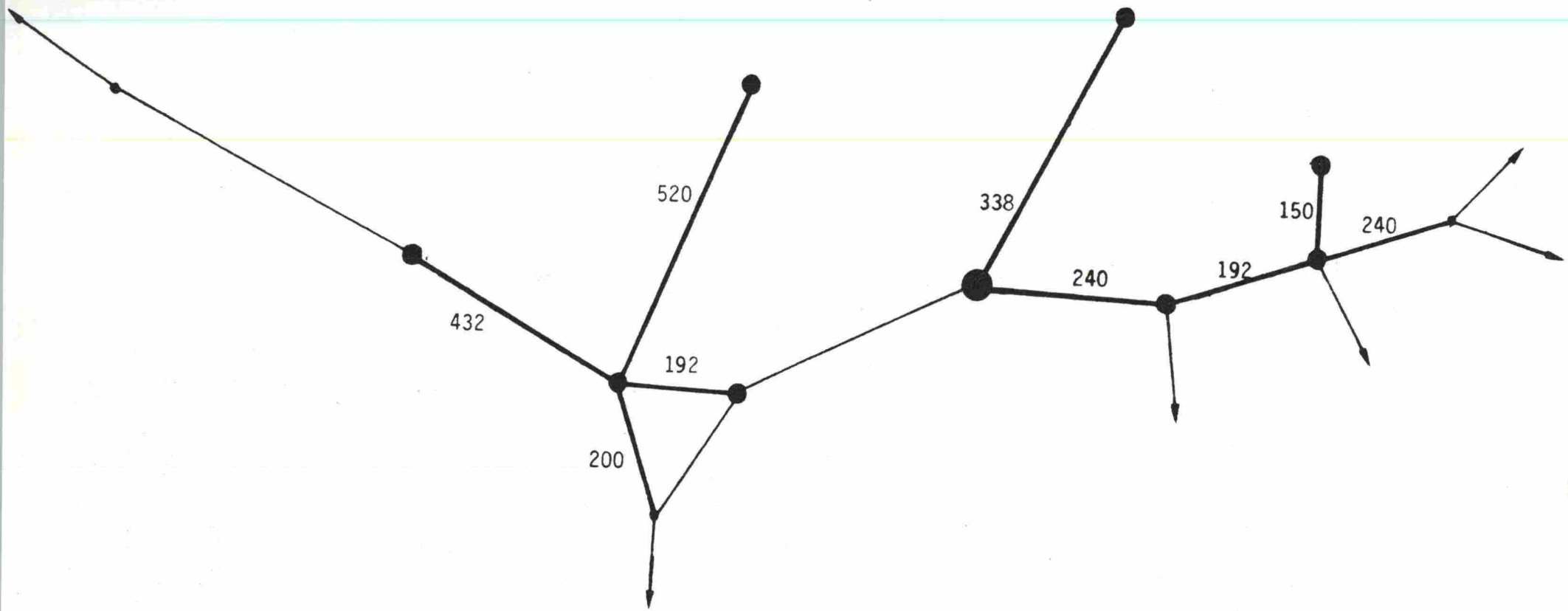
6.3 - THE FINANCIAL EQUILIBRIUM OF THE TRANS-SAHELIAN LINE

Assuming that there are 2,200 kilometres of railroad built (thus excluding the Tambao line) and that traffic flows are those set out in Map 8, we can estimate traffic on the new lines to be :

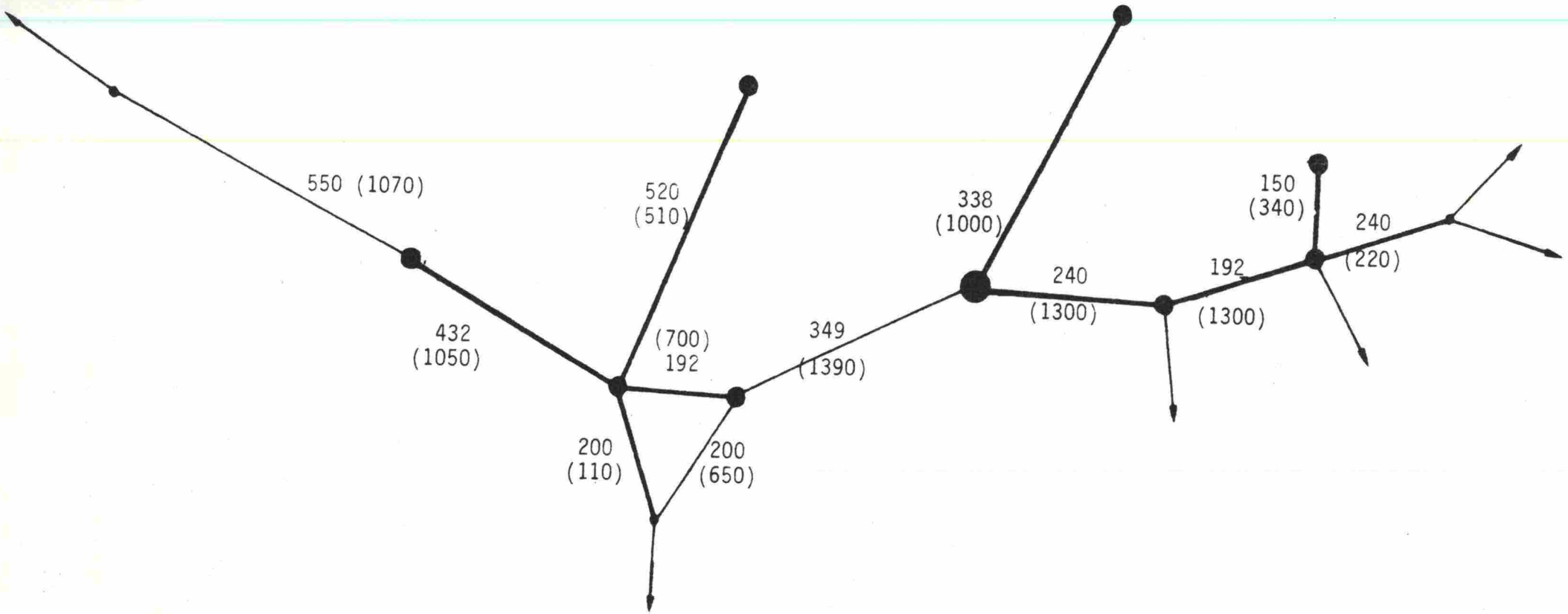
- 1,540 million tons-kilometre

By adding manganese (440 million t/km) and the transport of other products coming from the railways already in operation in the three states under consideration (1,100 million t/km) we can calculate traffic to total :

- 3,100 million tons-kilometre, plus
- 2,650 million, excluding manganese transported between Tambao and Ivory Coast.



The total for the new rail link-up (heavy lines) equals 2,504 kilometres including the Ouagadougou-Tambao link-up. If this last rail section in considered as having paid for itself with the sole transportation of manganese, then the total length of the new railways is 2,166 kilometres rounded off to 2,200 kilometres.



Traffic total in 10^6 kilometric tons : 3,088.2 rounded off to 3,100.

The figures give the distance in kilometres and the figures in parenthesis indicate the tonnage carried on the section under consideration in thousands of tons.

This figure may represent an order of magnitude for the traffic attracted by the new railway system. As we mentioned, certain sources of considerable traffic have not been itemized (see paragraph 5.1) and we have not included traffic coming from railroads located outside our three states, in particular the Senegalese railroads.

At first glance, we can estimate the cost price per ton/km (excluding the amortization of infrastructures and the financial charges connected with the investments for infrastructure) at 8 to 9 CFA francs, broken down as follows :

- $\pm$ 6 CFA francs per ton/km for variable costs

- 2 to 3 CFA francs for fixed costs, unrelated to traffic.

For the 2,200 kilometres of newly constructed rail lines, the annual operating costs would be approximately 13 billion CFA francs while income from the traffic presented on Map 8, using the hypothetical rates set out in paragraph 2.3 would be approximately 17 billion CFA francs (average income : 11 CFA francs per ton/km). We thus see that the company(ies) running the new lines can be assured of a positive financial balance with even enough traffic to provide for a certain financial flow.

Normally this financial flow should be increased by the surplus income obtained when operating costs are marginal, i.e. for some 1,100 million tons/km of traffic coming from the existing railways (excluding the transport of manganese ore). Since the fixed costs to be covered for traffic from the existing railways are relatively low, estimated at under 2 to 3 CFA francs per t/km for the new lines, these 1,100 million t/km should produce perhaps up to 4 billion CFA francs for use as financial flow per annum.

Let us again repeat that these figures - 4 billion CFA francs of financial flow from the new lines and 4 billion CFA francs from the additional traffic on the old lines - can only be used as plausible approximations, in keeping with our hypotheses. Further we must remember that this study is not a pre-feasibility study. We are not going to endeavour to calculate a profitability rate for the trans-Sahelian line ; considering the present state of this study, such a rate would hardly have any meaning. We think that we have demonstrated, moreover, that because of the effects of a trans-Sahelian route on the development of Sahel it would be unfair to judge its importance for the Sahelian states exclusively on the basis of financial returns on the investment.

We may conclude simply by saying that this sketchy approach shows that, using our hypothesis, a trans-Sahelian railway has every chance of breaking even financially and producing considerable funds to cover at least part of the financial charges and amortization of the investment costs.

6.4 - BENEFITS FOR THE COMMUNITY

Our estimate is based on the following method :

- if there is no trans-Sahelian railway, the needs in central Sahel for products coming from heavy industry, especially hydrocarbons, cement and fertilizers, will be met using South-North routes to carry goods from industrial points or ports receiving imports from outside the central Sahel economic zone ;

- if a trans-Sahelian railway is constructed, these needs will be met using the East-West or West-East route to bring in goods from production points located within the central Sahel economic zone.

Situation no. 2
(no trans-Sahelian line)

A_1 Relative value added in central Sahel with goods transported with the North-South system

B_1 Social cost of the transport infrastructure for the central Sahel zone concerned with the traffic flows under consideration

Situation no. 2
(with a trans-Sahelian line)

A_2 Relative value added in central Sahel with goods transported within the East-West, West-East system

B_2 Social cost of the other transport infrastructure for the central Sahel zone concerned with the traffic flows under consideration

C_2 Value added from industries

D_2 Social cost for the trans-Sahelian railway

Without resorting to a more detailed analysis, which could be made later, as a first estimate we feel that the following simplified formula could be used :

A_1 A_2 In situation no.2 nearly all the transport occurs in the zone being studied while in situation no.1 it only involves part.

B_1 B_2 In situation no.2 transport for heavy goods for the zone are handled by the trans-Sahelian line.

So situation no.2 - situation no.1 =

$$A_2 - A_1 - (B_2 - B_1) + C_2 - D_2$$

Therefore :

$$\text{Situation no.2 - situation no.1} = C_2 - D_2$$

In the first estimate, thus, a comparison of situation no.2 and situation no.1 means measuring local value added from industries under consideration in terms of the social costs of the railway.

. Social cost of the trans-Sahelian line

We estimate the cost for building the trans-Sahelian railway to be around 175 billion CFA francs, 1976 value. Of course the investment cost for the beneficiary communities will not be equivalent to the financial cost since a good part of the work will be carried out using resources available within the central Sahelian countries (especially the skilled and unskilled labour) thus generating a certain local value added. As an example, the report by the African Development Bank evaluating the Tambao project (Appendix IV.7) estimates that the local value added by the construction of the railway will amount to some 30 per cent.

Under these conditions we can consider the social cost for new railways to be close to 120 billion CFA francs (1976)

. Value added from new industries

There are two snags in determining the value added from new industries, especially the three heavy industries considered above i.e. cement, fertilizer, hydrocarbons.

- It is not possible to produce accurate evaluations on the basis of the projected economic context which by its very nature is imprecise ;

- The present value added for an industrial venture varies considerably according to the technical options, the quality of the operations, the managerial system and the upstream price systems. Therefore making an evaluation of this value added for industrial activities as forecast for the future is even more tricky.

This statement merits further explanation.

We can diagram the value of an enterprise's production using the following equation :

$$P = \left[\text{intermediate consumption} + \left[\text{components of the value added} \right.\right.$$

$$P = (Ci)_1 + (Ci)_2 + (Ci)_3 + \ldots + (Ci)_n + e_1 + e_2 \ldots + e_p$$

Each of these factors represents a percentage of the value of the output which, in turn, is the sum of factors of varying importance.

There is no reason for a given industry operating in different countries, enterprises or factories to e.g. produce clinkers from directly exploited limestone and clay, to assign the same relative weight to these factors.

It is merely that at a given moment we consider certain types of factories with certain characteristics to be "reasonable" and capable of guaranteeing a "normal" level of profits, with due regard for the prevailing technical and economic context. But a sudden technological advance or pressure from a powerful group capable of influencing prices can suddenly "antiquate" the factory or make it "non-profitable", thus reducing its value added rather substantially.

On the other hand if the prices of outputs soar without a correlative cost increase, the value added may be doubled, as happened with tropical woods in 1973.

To determine the value added for the industries examined above with greater accuracy we have used a three-step method :

- determine an operations schedule and a retrospective value added rate ;

- develop a scenario of an industrial profile for the sector considered for the year 2000 and determine a perspective rate for the value added ;

- apply this rate to the perspective value of production.

This procedure is presented in detail in Appendix 2.

We thus obtain a future value added of :

6,500 CFA francs per ton of cement,

21,000 CFA francs per ton of fertilizer,

1,300 CFA francs per ton of hydrocarbons.

Only the local percentage needs to be deducted from this value added. On the other hand we can add the value added for certain important intermediate consumptions (indirect primary effects).

To calculate the local percentage of the value added we hypothesized that the industries to be studied were state-owned industries and hence profits and wages transferred outside the state would be negligible (the staff would be composed of nearly only nationals by the year 2000). On the other hand, most of the amortizations would be transferred abroad to discharge debts contracted to finance the purchasing of foreign equipment.

Concerning the value added at the intermediate consumption stage, allowances have been made for electricity, maintenance and services, and the extraction of natural phosphates.

We arrived at the following values added :

- 4.7 billion CFA francs (1976) per year for cement factories
- 17.2 billion CFA francs (1976) per year for fertilizer plants
- 2.0 billion CFA francs (1976) per year for hydrocarbon plants

Which gives a total of about 24 billion CFA francs in value added, to which we must add approximately 3 billion CFA francs for the other industries included in the sectoral studies.

Altogether the local value added from industries growing thanks to the existence of the trans-Sahelian line, and which we have accounted for, could be around 27 billion CFA francs (1976) in the year 2000.

By waging this figure against the social outlay for the trans-Sahelian line (120 billion CFA francs), but without seeking to calculate the economic profitability (which would be premature) we can judge that the investment for the railway would have effects that are far reaching enough to more than justify the expenditure.

CHAPTER 7 - CONCLUSIONS AND ACTION PROPOSALS

At the beginning of this study we strongly emphasized that at this stage of reflection on the long-term future for the Sahel it was premature to try to demonstrate the feasibility of constructing a trans-Sahelian line ; we merely wanted to draw attention to the importance of such a route.

We think that we have reached our target by showing that the - large - investment required to build the railway is not, a priori, unreasonable and that the idea of a trans-Sahelian railway is worth studying at greater depth.

Let us recall the many results we have obtained :

1 the trans-Sahelian line would open the door to structuring industrial development around the needs of the Sahelian market and not condemn it to remain a subsidiary to the development of the coastal industrial poles, dependent on the routes leading inland from the coast ;

2 the trans-Sahelian line would ensure more reliable connections for the landlocked countries with the coast and greater assurance for the transport of supplies in case of drought ; we might even ask whether it is not a pre-condition to the achievement of the food self-reliance plan ;

3 the expected traffic on the trans-Sahelian line should allow the line to break even financially ;

4 the effects of the trans-Sahelian line on the economies of the countries it traverses should make the investment economically profitable.

We would like to underscore the first point. The trans-Sahelian railway could become the backbone around which the industry of the Sahelian states can take from. An African economist named Samir Amin used the following comparison : in the world of today the industrialized countries are the "centre" and the developing countries the "periphery". Only the "centre" can take decisions independently, the "periphery", at least economically speaking, being strongly dependent on the "centre".

The economies of the Sahelian countries illustrates this comparison clearly. They are little developed, fragile, poorly linked together and are located at the tips of long routes from the coast running inland.

At present we might say that they are the "periphery of the periphery". How can the Sahelian states secure the autonomy in development which they are seeking ?

- Certainly first by reaching a stage of food self-reliance so that they no longer have to systematically rely on the international community for food. The programme designed by the Sahel Club has shown that this is feasible.

- Then by developing the industry required to satisfy their own needs. We hope to have demonstrated that this would be practically impossible at present because industrialization in these states is very dependent on industrialization in the coastal states. The creation of a trans-Sahelian line might well be the condition needed to make autonomous industrial development possible.

Could this "different" structuring of industrial development in West Africa, made possible thanks to the trans-Sahelian railway, seriously hinder the industrialization of certain coastal states and thus arouse serious opposition ?

We do not think so.

The industries of the coast will, avowedly, be deprived of possible markets in the landlocked countries. But in general the production drop will be marginal. The development of the cement industry in Mali, Upper Volta and Niger, for instance, will deprive the CIMAO project of certain markets, but this is certainly of minor importance, in comparison with the breadth of the Ghanaean and Ivorian markets.

Furthermore, without even mentioning the political aspects of the issue it is certainly in the interest of the more highly developed coastal states for the landlocked countries to have more prosperous economies with which to entertain manifold commercial bonds rather than being limited to feeding in a few manufactured products to anaemic economies. Europe is an outstanding example of how the development of the less advanced economies also benefits the more advanced economies.

Now, when the Sahelian leaders become convinced of the potential importance of a trans-Sahelian railway, how can the idea be developed further ?

Two approaches seem to be possible.

The first consists of having each directly concerned country study and construct its own segment. We do not feel that this is a suitable approach. Wa have shown that the trans-Sahelian railway plan is to be taken globally, and that there is some doubt as to the profitability of each individual link. Further, since the effects of the trans-Sahelian railway are not expected to be felt for a long time, and each country has to cope with a multitude of urgent problems, national plans will probably give low priority to constructing the link, although the project could be beneficial to the whole region.

We thus feel that a joint approach from the directly concerned states would be the most appropriate. That is why we would like to suggest the following approach, which, undoubtedly, is not the only one.

a) Set up an ad hoc working group under one of the existing institutions such as CEAOW, the Sahel Club-CILSS, which would be responsible for studying the matter in depth. The study programme might entail :

- making several master plans for industrialization in West Africa to cover the main products. We have started doing this in our study and recommend the following minimum : fertilizers, cement, hydrocarbons. It seems vital to draw up a master plan for fertilizers, quite apart from any consideration for the trans-Sahelian railway, and master plans for the other two products seem highly advisable. It would be useful to place these sectoral outlines in a global perspective setting.

  The study of these master plans should give due heed to the construction of the trans-Sahelian line.

- carry out a study of conceivable traffic flows of agricultural, livestock and fishery products on the trans-Sahelian line, which was only alluded to in this study ;

- depending on the results of the industrial master plans and the traffic study, reflect on plotting routes and alternative routes, and evaluate approximate costs (construction and operating costs) ;

- conduct a pre-feasibility study for the trans-Sahelian line using all the available data.

b) If the results of this study are affirmative, the governments concerned should take a political decision which would cover not only the trans-Sahelian line (nature, route and construction), but also the strategy for the line's optimal use in accelerating the development of the Sahel, especially industrial development. As was indicated, although the existence of the trans-Sahelian line is essential to satisfactory industrial development in the Sahel, it is certainly not the only factor. A multinational industrialization policy will have to be defined and implemented.

c) After the decision has been made, the ad hoc working group would create a "Trans-Sahelian Office" to carry the study further and definitively plot the line, develop a pre-project and conduct a feasibility study. The Office would then be charged with securing financing and materializing the project.

In conclusion let us note that the trans-Sahelian railway could be one of the prime elements of a future master plan for the transport network of the Sahel, but it cannot be the only one and that whatever be the case, a master study including the trans-Sahelian railway would be advisable.

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- "Perspective study on agricultural development in Sahelian countries" (FAO, Rome, 1976)

- Work carried out by the Development Research Centre of the University of Michigan ("Recent Economic Evolution of the Sahel" by Professor Berg).

- Work carried out by the Sahel Club i.e. :

  . the work of the irrigated crops team,

  . the work of the dryland farming team,

  . the synthesis report "Strategy and Programme for Drought Control and Development in the Sahel" (OECD, May 1977).

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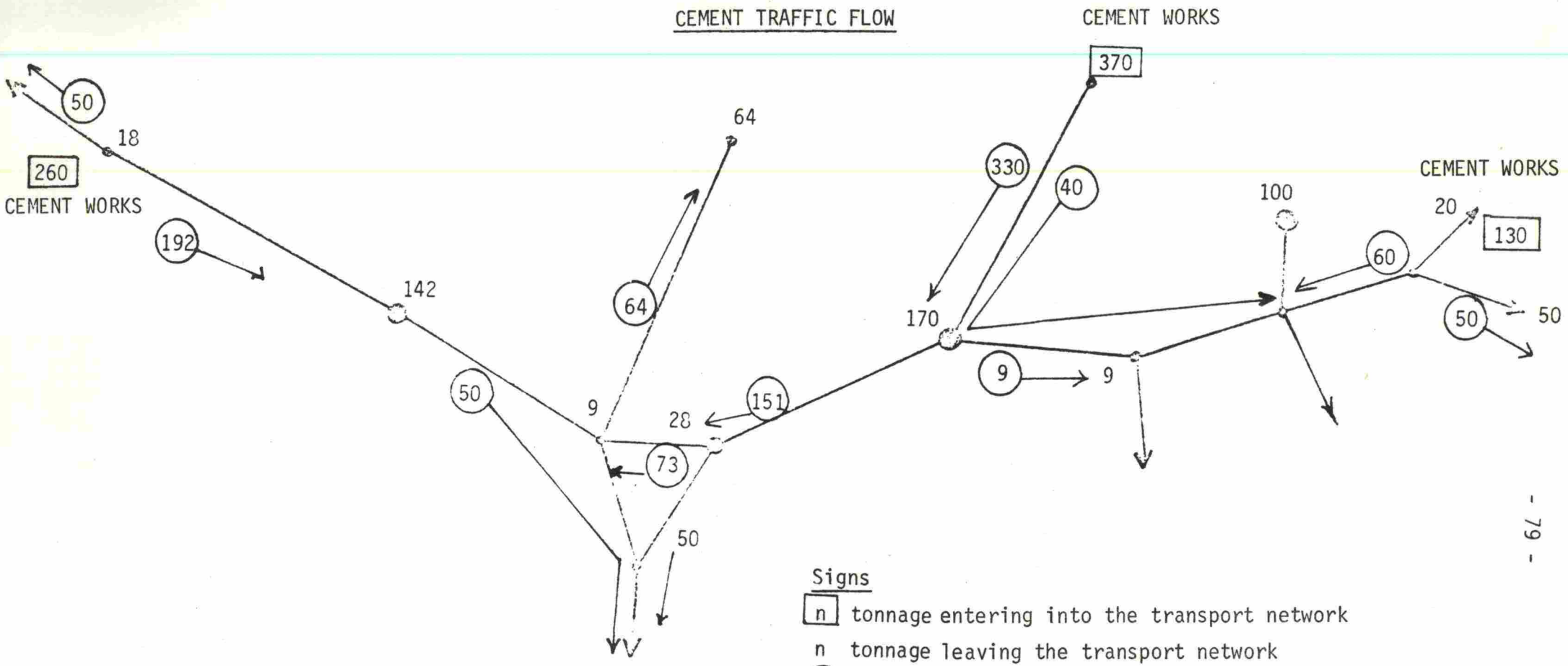
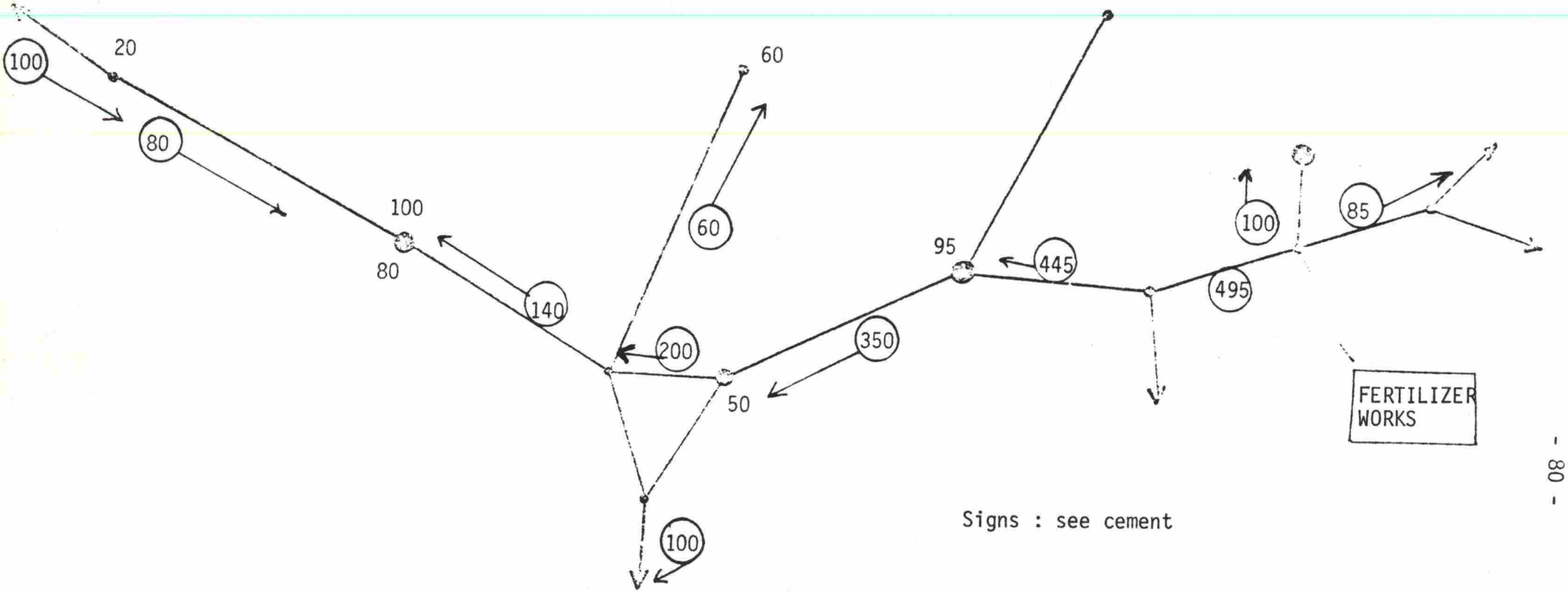
- Various internal documents at SEMA, especially those from the future prospects department.

ANNEX 1

TRAFFIC FLOWS OF CERTAIN IMPORTANT PRODUCTS

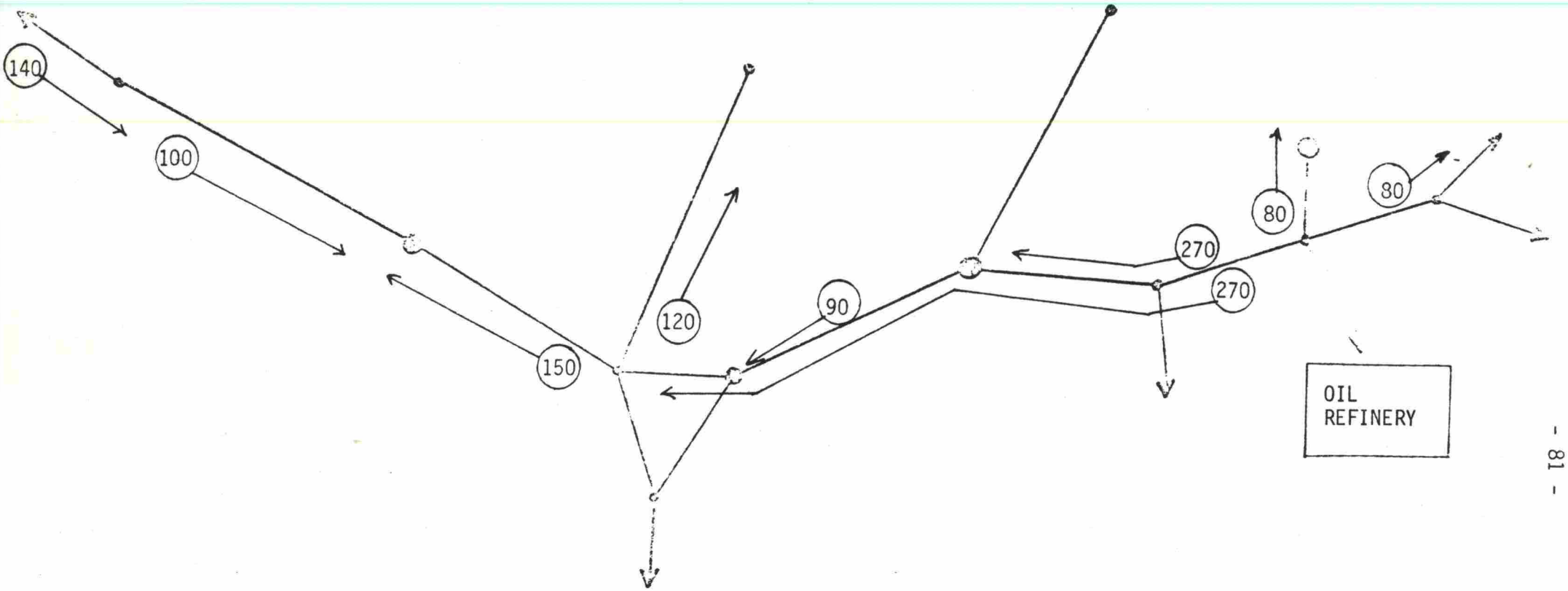

CEMENT TRAFFIC FLOW
CEMENT WORKS
370
330
40
260
CEMENT WORKS
50
18
192
142
64
64
50
9
28
151
73
50
170
9
9
100
20
130
60
50
50
CEMENT WORKS
Signs
n tonnage entering into the transport network
n tonnage leaving the transport network
n transferred tonnage
figures in 1,000 t/year

FERTILIZER TRAFFIC FLOW



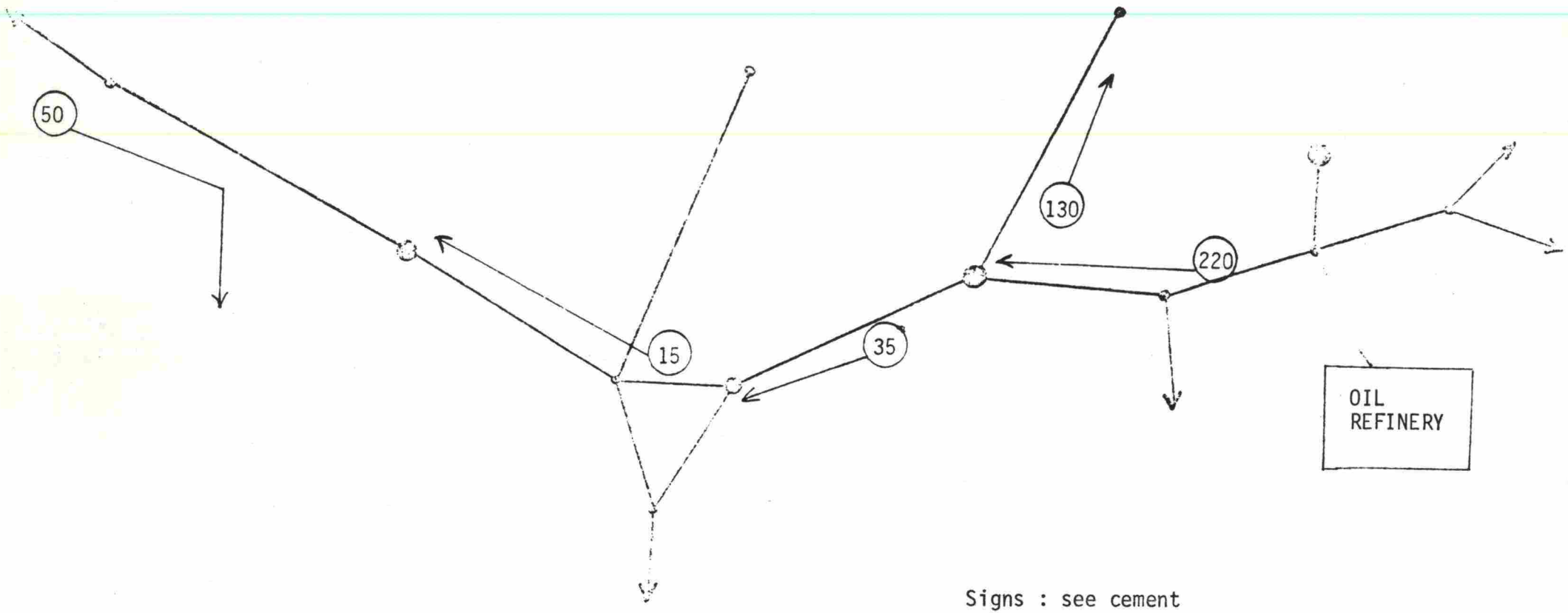
Signs : see cement

LIGHT HYDROCARBON TRAFFIC FLOW



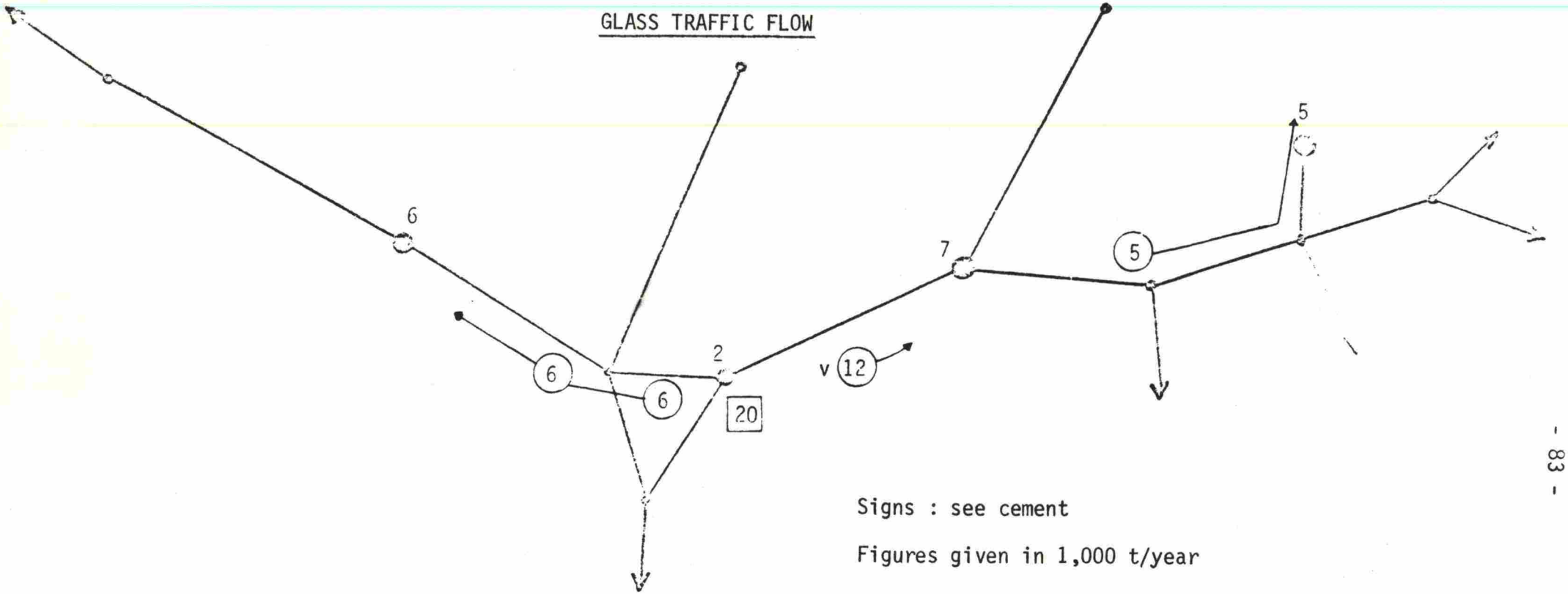
Signs : see cement

HEAVY HYDROCARBON TRAFFIC FLOW



Signs : see cement

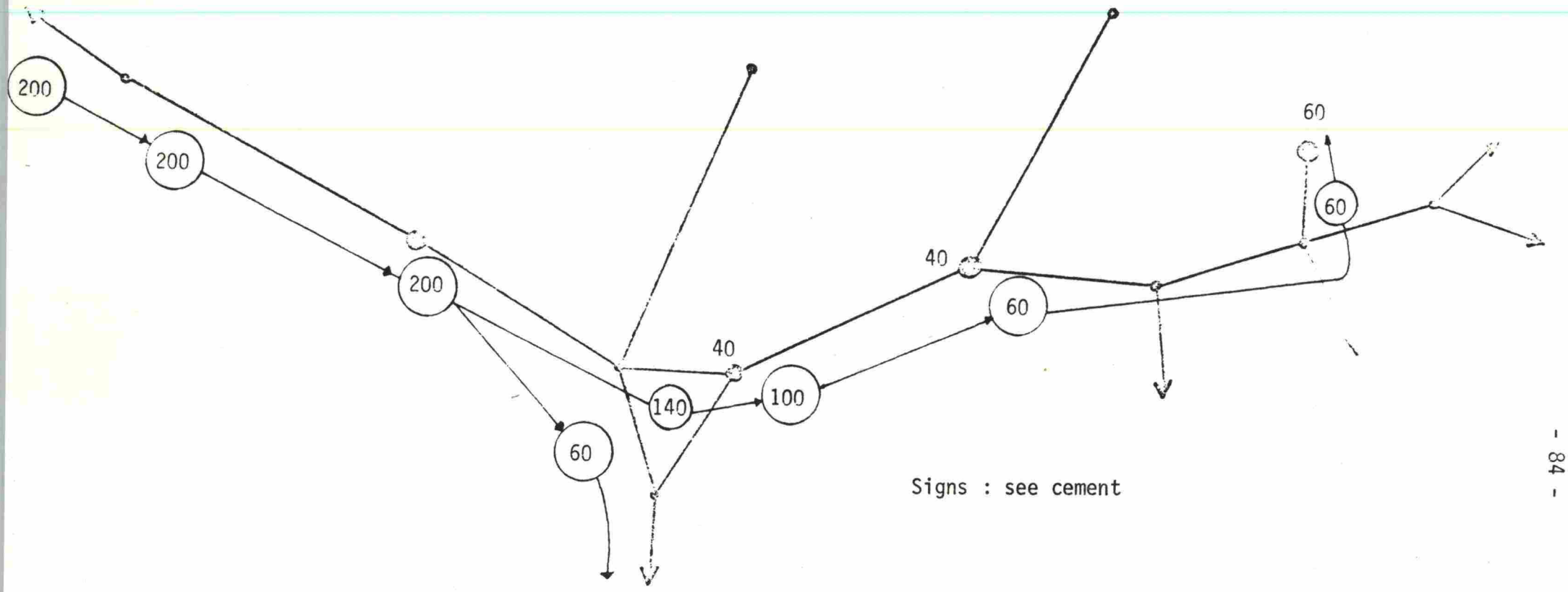
GLASS TRAFFIC FLOW



Signs : see cement

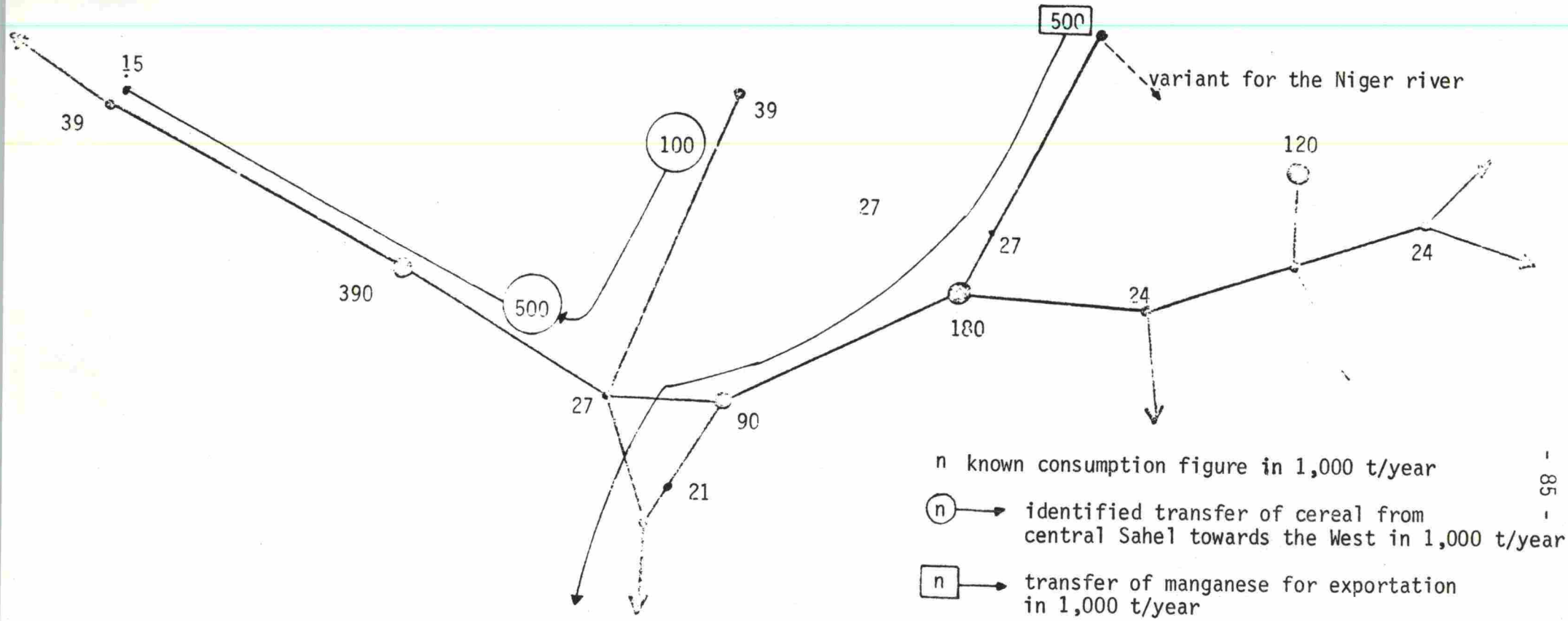
Figures given in 1,000 t/year

SEA SALT TRAFFIC FLOW



Signs : see cement

MINING AND AGRICULTURAL PRODUCTS



ANNEX 2

CALCULATION OF THE VALUE ADDED FOR NEW INDUSTRIES

A - CEMENT FACTORIES

I - RETROSPECTIVE INDUSTRIAL PROFILES

- 1972 OECD Manual : study of a cement factory

Plans for a 200,000 ton factory :

- direct gross value added :

52 per cent broken down as follows

. personnel	12 %
. amortization and financial costs	17 %
. results and other	23 %

- intermediate inputs :

48 per cent broken down as follows :

. purchasing materials (minerals)	9 %
. energy	23 %
. maintenance services and manufactured goods	16 %

- Profiles of manufacturing establishments, United Nations. Cement factories in East Africa, founded in 1964 (data : 1970)

- direct gross value added :

63 % per cent broken down as follows :

. personnel	15 %
. amortization and financial charges	22 %
. results and other	26 %

- intermediate inputs :

37 per cent broken down as follows :

. purchasing materials (minerals)	8 %
. energy (half for fuel)	15 %
. maintenance services and manufactured goods	14 %

- Profiles of manufacturing establishments, United Nations

400,000 ton cement factory in East Europe, founded in 1893 (data : 1967)

- direct gross value added :

48 per cent broken down as follows :

. personnel	15 %
. amortization and financial charges	20 %
. results and other	13 %

- intermediate inputs :

52 per cent broken down as follows :

. mineral materials	8 %
. energy (half fuel)	25 %
. maintenance services and manufactured goods	19 %

- Profiles of manufacturing establishments United Nations

330,000 ton cement factory in Yugoslavia, founded in 1956 (data : 1963)

- direct gross value added :

54 per cent broken down as follows :

. personnel	13 %
. amortization and financial charges	16 %
. results and other	25 %

- intermediate inputs

46 per cent broken down as follows :

. purchasing mineral materials	3 %
. energy	21 %
. maintenance services and manufactured goods	22 %

Considering the industrial profiles of existing factories presented above, the retrospective industrial profile for the average cement factory could be as follows :

- direct gross value added

  52 per cent broken down as follows :

. personnel	15 %
. amortization and financial charges	18 %
. results and other	19 %

- intermediate inputs :

  48 per cent broken down as follows :

. purchasing mineral materials	8 %
. energy (half fuel)	22 %
. maintenance services and manufactured goods	18 %

II - INDUSTRIAL PROFILES AND PROSPECTIVE VALUE ADDED RATES

Relative rises in prices and their components as a durable, long-term modification will be the result of durable international or regional trends. Some of these changes can already be identified, others will appear later and are not yet known.

There are two trends of an international nature that, very probably, we can expect for the end of the century :

- near depletion of oil resources for energy will trigger off a relatively substantial increase in the price of energy ;

- gradually shifting of certain industries to the Third World countries, especially the Far East will depress the price of manufacturing goods which at present are made exclusively in the highly industrialized countries. This drop will also apply to industrial equipment and machines not made using peak technology (e.g. electronics, computerized information, aviation, nuclear sciences,etc) this especially applies to the equipment for cement factories.

In order to apply these two trends to the cement factories, we will use the following hypotheses :

A the relative price of energy made from oil will be tripled and the price of hydraulic energy will remain unchanged,

B the price of factory equipment and other manufactured products will drop 33.3 per cent.

We think that we can identify three trends at the regional levels :

- Industries will have access to aid funds to finance their investments, thus long-term financial costs will be decreased ;

- Foreign supervisory staff will be wholly replaced by Sahelians well before the year 2000. On the other hand, workers' salaries will increase and thus offset the drop in the wage expenditure obtained by replacing the expatriates ;

- These industries will generate relatively little profits and tax money since they are vital to the agricultural development which has economic difficulties and is enshrouded in international aid.

To apply these trends to the cement sector we will use the following hypotheses :

C Financial charges will drop by 66.6 per cent,

D The labour cost will remain unchanged,

E Results, including taxes will be decreased by 33.3 per cent.

Bearing in mind hypothesis B which applies to both the amortization and the maintenance supplies heads, we can sketch a total new profile as follows :

	%	%	
- Labour	15	14	Projected rate of gross value added : 38 per cent
- Amortization	6	6	
- Financial charges	6	6	
- Results, taxes, other	12	12	
- Purchasing mineral materials	8	8	Prospective rate of intermediate consumption : 62 per cent
- Energy	44	42	
- Maintenance services	12	12	
	103	100	

III - PROSPECTIVE VALUE ADDED FOR THIS SECTOR

As for the value added rates, the projected price for cement in central Sahel in the year 2000 depends on both international and regional factors.

The international price for cement will have risen. If we revert back to the calculation in the preceding paragraph without reducing the rate of the financial charges (leaving other modifications as they appear), the price will be increased by a total of about 6 per cent.

On the other hand, if we consider regional trends in central Sahel, the price of cement (in relative value) should be lower even if we only consider that access charges alone have been decreased thanks to the existence of cement factories in central Sahel.

In 1974 the price the cement was sold to wholesalers in Ndjamena was five times higher than the price charged at Dakar or at Abidjan and eight times higher than in France ; in Mali the price was three times higher than the cement sold at the coast.

This price should be close to the coastal price if the central Sahel cement factories are to compete with the coastal cement factories. In 1976 the wholesaler paid about 12,000 CFA francs for a ton of cement in Abidjan or Dakar. Expressed in 1976 francs, in the year 2000 the price of cement would be about 13,000 CFA francs per ton at Abidjan or Dakar.

The transport costs from Abidjan to the iso-price line (North Ivory Coast or Dakar-Kayes or Lomé-Upper Volta border i.e. 500-600 km. in each case) can be estimated at 7,500 CFA francs (1976), i.e. 60 per cent of the original cement price

Considering the marginal costs policy for cement factories in the peripheral markets and the territorial price equalization policy governments are likely to adopt, Sahelian cement factories would have average costs hardly more than 30 per cent higher than those registered at the coast, i.e. 17,000 CFA francs for a ton of cement from the factory in central Sahel in the year 2000 with a value added of 6,500 CFA francs per ton (1976 francs).

B - FERTILIZER PLANTS

I - RETROSPECTIVE INDUSTRIAL PROFILES

- Ammonium sulphate and single superphosphate factory in Mexico producing part of its needs for the ammonium and sulphuric acid.

- Production

  125,000 tons of ammonium sulphate
  85,000 tons of superphosphate

- gross direct value added

  45 per cent broken down as follows :

. personnel	14 %
. amortization	7 %
. financial charges	1 %
. results	23 %

- intermediate inputs

  55 per cent broken down as follows :

. sulphur	12 %
. ammobia	7 %
. sulphuric acid	2 %
. phosphate	11 %
. natural gas	3 %
. energy (half for fuel)	9 %
. maintenance, services and manufactured goods	11 %

- Chemical products and fertilizer complex in central Europe founded in 1939 (data : 1967)

The line of products made since 1952 :

- ammonium sulphate
- phtalic acid
- sulphuric acid
- pharmaceuticals
- superphosphate
- urea
- maleic anhydride
- fertilizer
- nitric acid
- phosphoric acid

1967 productions were as follows :

- fertilizer : 1,250,000 t or 62 per cent of the turnover
- organic chemistry : 31,000 t or 13 per cent of the turnover
- inorganic chemistry : 166,000 t or 9 per cent of the turnover
- fungicides, insecticides, pharmaceuticals : 1,300 t or 7 per cent of the turnover
- other 9 per cent of the turnover

An analysis of the operations account indicates the following :

- gross direct value added

  46 per cent broken down as follows :

. personnel	26 %
. amortization (machines 80 per cent)	10 %
. financial charges	2 %
. results and taxes	8 %

- intermediate inputs

  54 per cent broken down as follows :

. coal gas	4 %
. natural gas	2 %
. phosphate	5 %
. alcohol	3 %
. potassium sulphate	2 %
. other	15 %
. energy (including 70 per cent electricity)	9 %
. maintenance services and supplies	14 %

- Ammonium sulphate, double salts and urea complex founded in India in 1952 (data : 1964)

In 1967 the factory produced :

- 311,000 tons of ammonium sulphate
- 48,000 tons of double salts
- 18,000 tons of urea

The factory uses primary raw materials (charcoal, refinery gases, gypsum, working using nitric acid, ammonium and liquefied gases).

Gypsum is extracted from the Company's deposits :

- gross direct value added

  33 per cent broken down as follows :

. personnel	19 %
. amortization (including 90 per cent for machines)	13 %
. results and other	1 %

- intermediate consumption :

  67 per cent broken down as follows :

. raw materials	40 %
. energy	8 %
. maintenance services and supplies	19 %

- Superphosphate factory founded in India in 1961 (data : 1965)

In 1965 the factory produced and sold 34,000 tons of concentrated superphosphates and produced the sulphuric acid component it needed. Phosphate is bought outside the factory.

- gross direct value added

  12 per cent broken down as follows :

. personnel	6 %
. amortization	3 %
. results	3 %

- intermediate consumption

  88 per cent broken down as follows :

. phosphate (including 14 per cent for delivery)	40 %
. sulphur (including 4 per cent for delivery)	16 %
. energy	3 %
. maintenance services and supplies	29 %

- Study of the Tunisian chemical industry sector (1969 industrial survey - INS Tunis)

This survey covered 12 establishments with 1,755 wage-earners. They produced, in 1969 :

- triple superphosphate	:	330,000 t	Equivalent to 83 per cent of the value of the factories output (13 million Tunisian dinars)
- single superphosphate	:	32,000 t	
- hyperphosphate	:	54,000 t	
- mixed fertilizers	:	5,700 t	
- other	:	8,000 t	

- gross direct value added

  19 per cent broken down as follows :

. personnel	15 %
. amortization	3 %
. results	1 %

- intermediate inputs :

. phosphate	25 %
. sulphur	23 %
. other raw materials	6 %
. energy	3 %
. maintenance services and supplies	24 %

II - RETROSPECTIVE INDUSTRIAL PROFILES

There are rather few petrochemical complexes that produce a complete array of phosphate and nitrogen enriched fertilizers using barely processed raw materials, therefore there are rather few studies available. The preceding industrial profiles enable us, however, to sketch an average retrospective profile for a fertilizer complex in the Sahel :

- value added	42 % including
. personnel	20 %
. amortization	10 %
. financial charges	1 %
. results	11 %
- intermediate inputs	58 % including
. raw materials	35 %
. energy (including 0.2 per cent fuel)	9 %
. maintenance services and supplies	14 %

- Industrial profiles and prospective value added rates

In view of the above, the industrial profile should be :

- value added	35 % including
. personnel	20 %
. amortization	7 %
. financial charges	1 %
. results	7 %
- intermediate inputs	65 % including
. raw materials	44 %
. energy	12 %
. maintenance services and supplies	9 %

The value added rate for the type of factory we are considering should be reduced from 42 to 35 per cent mainly because of the increase in the price of raw materials and energy and the decrease in the price of equipment.

It should be pointed out that as a result of the above the relative value of fertilizer would tend to remain unchanged.

III - PROSPECTIVE VALUE ADDED FOR THE SECTOR

Fertilizer prices vary greatly. Just as an example, Europa Chemical News and Chemical Marketing Report in October 1977 quoted the following approximate prices (which are little different from the October 1976 prices) FOB in the country of origin :

- urea	40,000 CFA francs 1977/ton	
- superphosphate (at 10 per cent P205)	18,000 CFA francs/t ex Federal Republic of Germany	
	15,000 CFA francs/t ex Belgium	
- ammonium sulphate	110,000 CFA francs/t ex Germany	
- ammonium nitrate	30,000 CFA francs/t ex United States	
	20,000 CFA francs/t ex Italy	

We see that differences are great.

The average value of fertilizer imported into Mali in 1974 was 50,000 CFA francs/ton CIF Malian border.

FAO data indicates that the average price in 1976 for central Sahel was 90,000 CFA francs/ton. This price was more or less confirmed by the SEMA study conducted for CEAO.

We have shown that estimates we plan to propose for the year 2000 will be very imprecise, but for reference purposes we are taking the average price for fertilizer in central Sahel to be 70,000 CFA francs (1976) per ton ex-factory.

Under these conditions, the gross direct value added would be 21,000 CFA francs (1976)/ton.

C - PETROLEUM REFINERY

Considering the tremendous fluctuation in the prices charged for crude and refined hydrocarbons, and the small margin of value added in refining (measured against the price of hydrocarbons) it seemed advisable to study the industrial operation separately.

A study of the data from the Abidjan refinery indicates that we can estimate the value added in the refining operations at 1,300 CFA francs (1976) per ton of processed crude oil.

D - CALCULATION OF THE LOCAL SHARE IN THE VALUE ADDED AND THE INDIRECT PRIMARY EFFECTS

Amortizations transferred abroad, bring about a reduction in the previously calculated value added :

- cement factories : reduction of 6 per cent, i.e. 1,020 CFA francs per ton
- fertilizer factories : reduction of 7 per cent : i.e. 4,900 CFA francs per ton
- refineries : reduction of 400 CFA francs per ton

Certain intermediate inputs can create local value added, especially for hydraulic electricity and phosphates which carry local values added equal to half the above figures. The same applies to maintenance and services (40 per cent local). The foolowing corrections need to be added :

- Cement

  + 5.5 per cent for hydraulic electricity

  + 5.0 per cent for service and maintenance

  Total 10.5 per cent i.e. 680 CFA francs (1976)/ton

- Fertilizers

  + 5.0 per cent for phosphates which represent 10 per cent of the value of the output

  + 2,5 per cent for electricity

  + 3.5 per cent for maintenance and services

  Total 12.0 per cent, i.e. 8,400 CFA francs (1976)/ton

- Hydrocarbons

  Increase of 80 CFA francs (1976) per ton

- Resulting local value added

  . Cement :

  (6,500 - 1,020 + 680) x 760,000 t/year = 4.7 billion CFA francs (1976)/year

  . Fertilizers

  (21,000 - 4,900 + 8,400) x 700,000 t/year = 17.2 billion CFA francs (1976)/year

  . Hydrocarbons

  (1,300 - 400 + 80) x 2,000,000 t/year = 2 billion CFA francs (1976)/year.

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