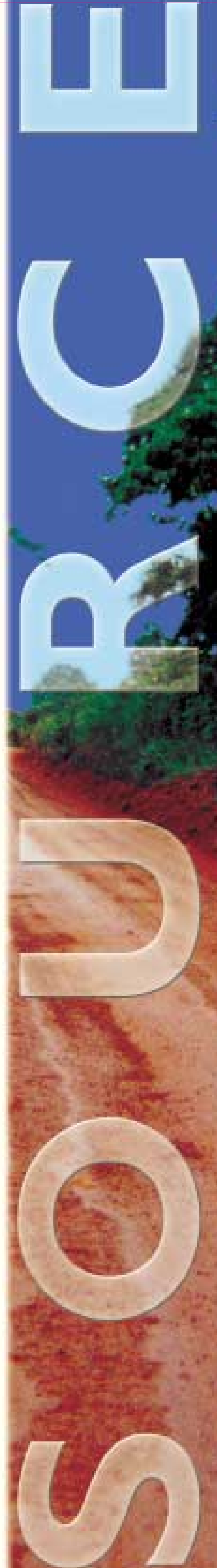
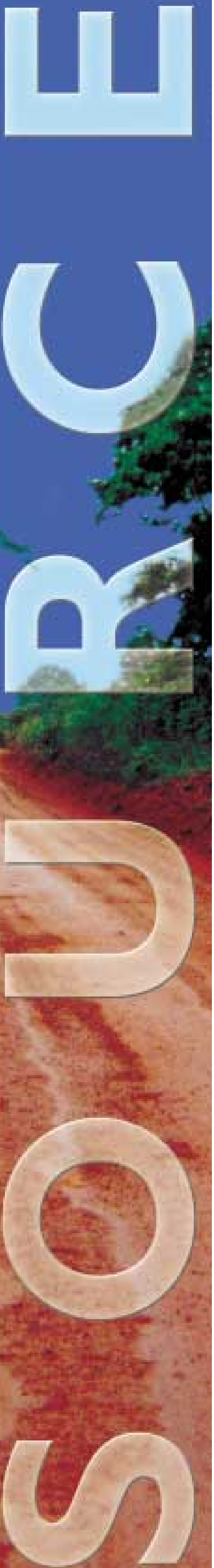
Roads

in Developing Countries, Management and Monitoring

a large-scale benchmark tool
for road networks





About RMI

The Road Management Initiative (RMI) is a central component of the Sub-Saharan Africa Transport Policy Program (SSATP), a joint undertaking of the United Nations Economic Commission for Africa (UNECA) and the World Bank.
The primary objective of the RMI has been to secure sustainable improvements in road sector performance in Sub-Saharan Africa. The RMI is now an efficient, flexible tool, enabling countries to identify and address their road management policy problems. RMI experience has demonstrated that, to be effective, reforms must be country-specific and involve both public and private sectors in genuine partnerships. Both African beneficiary countries and donors are involved in the RMI agenda, from defining to monitoring. Program management is the responsibility of the World Bank. The RMI receives sponsorship from a number of bilateral donors, as well as the European Union and the World Bank.

Sub-Saharan Africa Transport Policy Program (SSATP)
The World Bank and Economic Commission for Africa

About ISTED

ISTED, a non-profit organization, is a forum for study and debate, information and action, at the service of its public and private members in the public works, transport, country planning and environment sectors. It facilitates their international activities - primarily in non-OECD countries -, disseminates French knowhow throughout the world, and helps to implement international programs and projects with third country leaders.

ISTED unites several categories of members: companies, consultants, scientific institutions, and trade, teaching and research bodies. It also works closely with the French line Ministries in charge. ISTED's core missions relate to information interchange and dissemination. ISTED implements different operational actions: partnership programs, network guidance, appraisals and expert advice.

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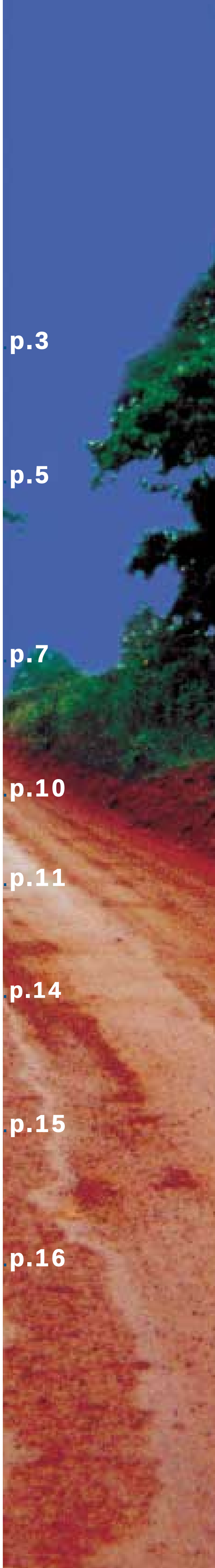


(1) S.O.U.R.C.E. : Standard Overall Ultralite Road Care Estimate

How the SOURCE project began

Major changes in the road sector

Over the past ten years, a wind of institutional reform has been blowing over the road sectors of a number of African countries. It has been supported and encouraged by donors, particularly through the Road Maintenance Initiative (RMI), a SSATP component (Sub-Saharan Africa Transport Policy Program). New mechanisms have been introduced, such as the debudgeting of road maintenance resources or direct participation of road users in management bodies. And with redefined rules: enhanced market logic, more decentralization, and new types of operators.

In fact, this institutional Meccano has been built up throughout the developing countries or those in the throes of change, with cross effects. Africa has drawn inspiration from Latin America, then West Africa from East Africa, and in turn, Central and Eastern Europe…, with the effects of successive generations that sometimes interrelate. Some countries have undergone vagaries, blockages, setbacks. Many countries have undeniably made progress.

What tools to measure and analyse progress?

At the same time, signs of methodological errors are detected here and there. For example, the long-term void often left by the closing down of public plant pools when market prospects and conditions were not sufficient to create supply. Other aspects, proven by the facts, also deserve to be re-examined.

"Proven by the facts"! A requirement logically put forward by all the partners involved in these processes, whether stakeholders in the road sector or donors. They all have a pressing need for efficient monitoring instruments to assess progress, achievements and the eventual relevance of recommended reforms. **Which means capitalizing while exercising sound judgement.**

Within the countries, the new management bodies in which road users are associated generate increased demand for easy-to-use, objective performance monitoring methods for the road sector. If a road hauliers' representative is to accept, extend or increase a "road maintenance tariff", and convince his mandators of its relevance, he will in turn need regular, concrete measurements of the results.

The general question of "How to correctly monitor and assess progress in road maintenance" is thus relevant both within each country and at an overall level.

Upstream answers, downstream answers

Upstream, there must obviously be monitoring of institutional progress, for which new tools are being set up. These tools measure the political will reflected by a reform, but not the operational efficiency.

There is also conventional monitoring of the implementation of intervention programs or the functioning of the new road agencies themselves: technical audits and management audits. This involves checking that the machine is working properly "as is", but does not extend to its ultimate efficiency.

Downstream, in terms of field results, the engineer has a full range of excellent, proven tools and methods to assess road condition. In increasing order of quality and accuracy of results (but at the same time, in increasing order of complexity and cost): visual, multi-criteria surveys on damage, roughness or equivalent measurements and deflection measurements. None of these tools, even the lightest, (windscreen surveys) is suitable for overall, recurrent, large-scale monitoring, for which they have not been designed. Their field of excellence begins at the preprogramming stage of work. Besides requirements for heavy logistics and specialized skills, the cost of these campaigns over a main road network would usually be politically unjustifiable, weighed against the meagre budget devoted to road maintenance. When the monitoring cost is more than a quarter of the cost of maintenance work, it is impossible to "keep up". We must change tools.

In terms of road policy monitoring and assessment, except for a few countries, we come up against a void in terms of reliable tools.

The status of road statistics

Here again, the facts speak for themselves, better than any arguments. It is a fact, that commonly-used road statistics in the form of national aggregates are mostly qualitative (despite appearances which are deceptive) and in fact unworkable. It is a fact, that far too few countries have permanent road data banks, locally managed and regularly updated, based on objective technical data.

Example: out of 45 African countries interviewed in 1998, 41 replied that their data bases did not meet these criteria, 20 road administrations could only provide statistics that were "commonly accepted but with no precise statistical basis".

And it is a fact that overall traffic-related data are rarely available except under specific programs.

That is why in practice, large-scale systematic monitoring can only exceptionally be directly based on a pre-existing road data bank.

On a supranational scale (for country-to-country comparisons), the homogeneous nature of present statistical series hides two major defects: the lack of unified criteria (from the measurement of deflection to "what the expert says"), and reference networks that are extremely inconsistent and unstable (in the series examined, we see stop-and-go effects reaching [-66%] over 8 years. The extent of these defects is such that they can cause complete misinterpretation of the basic question "progress / no progress?".

SOURCE – to provide factual proof

What is the real state of the road network?
How do new and rehabilitation work programs stand the test of time?
What is the actual level of service provided for users?
How is this level of service changing?
Does the response from the road sector match up to potentialities and requirements? Etc.

The answers to these crucial questions for road and road transport policy, provided by existing statistics and data, are few and far between.
But monitoring of the actual level of service of the road network, taken as an overall indicator of the physical performance of a network, is precisely the aim of the "SOURCE" project launched in 1998 by the RMI, which enabled the SOURCE method to be fine-tuned and validated.

The aim of the SOURCE project was to create and test a low-cost, simple, practical tool, to monitor the status of the road network in a country by an objective, easy, standardized method: **an overall benchmark instrument.**

The idea: supply on a country-by-country basis, an accurate standard picture of the main network, produce aggregate front-line information of well-controlled statistical quality (not determined by the availability or quality of already-existing bases).

The key-product (but not the only one): a single macro-indicator per country, which will be the most relevant tool for users.

SOURCE, a brief insight

The actual level of service offered by the road network (i.e. the quality of service) is assessed through mean travel times, the most direct expression of users' "expectations" (in fact, measuring these mean travel times or measuring mean travel speeds makes no difference).
A complementary assessment of traffic volumes also measures the quality of service in terms of production of road transport.

Speeds weighted by traffic volumes

The SOURCE method is based on standardized measurements of traffic and common speeds of light vehicles, made for each country over a standardized reference network. The two series of data (traffic / speeds) are aggregated for the entire reference network in the form of a single macro-indicator (a pseudo-speed) that reflects the actual level of service provided by the main roads in each country. Various by-products are also obtained, which naturally include a macro data bank for the network in question.

At the centre of the method: the floating vehicle

Speed and traffic levels are measured simultaneously using the special "floating vehicle" protocol. An ordinary vehicle (the floating vehicle) is integrated into the traffic and alternatively follows a fast vehicle (which has overtaken it) and a slow vehicle (which it has caught up). On the way, the traffic encountered in the opposite way is counted. This procedure is detailed in annex.

SOURCE, An ultralite method

Minimum equipment of the measuring team

YES:

- ***Vehicle (**ordinary **4-wheel drive)***
- *Timer*
- *Ordinary road maps*
- *Pocket calculator*

NO:

- ***No** microcomputer,*
- ***no** radio transmission equipment,*
- ***no special instrumentation systems.***

Both in the field and at the office, this method is simple. The calculation and edition workbooks (see annex) are plus factors in terms of productivity and comfort, but they are not even really indispensable. Therefore no category of service provider is advantaged. Local engineering firms are perfectly capable of using the method.

A statistical integrator

The accurate measuring protocol assigned to the floating vehicle makes it a "statistical integrator" able to provide high-quality results. This is the key to the method. It means that once is enough for this "living" statistical integrator (so to speak) to travel the entire network under review, at speeds close to common speeds, without fixed facilities or instrumentation systems.

Common LV speed: a judicious approach

Experimenting has shown that measuring the common speed of light vehicles (LVs) in the dry season offers sufficient correlation with the surface condition of a road (unlike the common speed of lorries, owing to the unknown load factor). The method does not have to take into account other permanent speed-influencing factors (such as the type of road alignment).

The method applies indiscriminately to paved and unpaved roads unlike conventional methods of assessing road condition, all of which are discontinuous by nature.

Through suitable processing of the various distortion factors and after adjustment, the sensitivity of the indicator to disparities or changes in the car population is of minor significance (because the speeds are systematically levelled off at 90 km / h). **As a result, despite the low cost of the macro indicators, their configuration guarantees adequate statistical soundness (the specified quality thresholds are attained for any distance of at least 150 km).**

Reference networks – for country-to-country comparisons

A fundamental aspect of the SOURCE method for making comparisons is the establishment of specific reference networks (on which the measurements are made), which statistically reflect basic transport requirements. They take urban demography into account in a standardized manner, with additional criteria for trans-border routes, port areas and transit or regional development corridors, excluding consideration of traffic levels.

The reference networks are classified into 4 ranks of priority depending on the extent of transport requirements (as for the measurement method, the rank makes no difference).

These networks act rather like "the housewife's shopping basket" used to monitor consumer prices. They change little over a time scale of a few years and they are restricted enough to always be within the priority networks determined at national level. It is essential to use these reference networks (only the 3 main ranks) as a basis for making comparisons between countries.

However, each SOURCE measurement campaign in a given country deserves to be extended to the national priority network. By producing a double series of statistics in this way, it is possible to satisfy two complementary visions (national and transnational).

The recommended usual frequency for assessing overall network condition from this objective angle of service provided for users, is one measurement campaign every three years. Measurement campaign costs and logistical constraints are minimized, for an abundant yield of results. Direct field costs: USD2 per km measured.

Warning concerning the goals

SOURCE indicators are not intended to replace conventional data on road condition. *The scale of SOURCE data collection (scale of dividing up the network) would not be small enough to meet requirements for daily maintenance management or work programmming, etc. The SOURCE method does not generate the detailed road data bank that is required for road operations, but exclusively a sound "macro data bank".*

SOURCE provides the minimum information, no more no less, essential to:

- *Authorities in charge of roads, to justify to user-payers the performance levels obtained on the network, through transparent, well-informed dialogue,*
- *Decision-makers at all levels, to assess the impact of road policies on the basis of physical results.*

In brief, to enlighten macro-decisions.

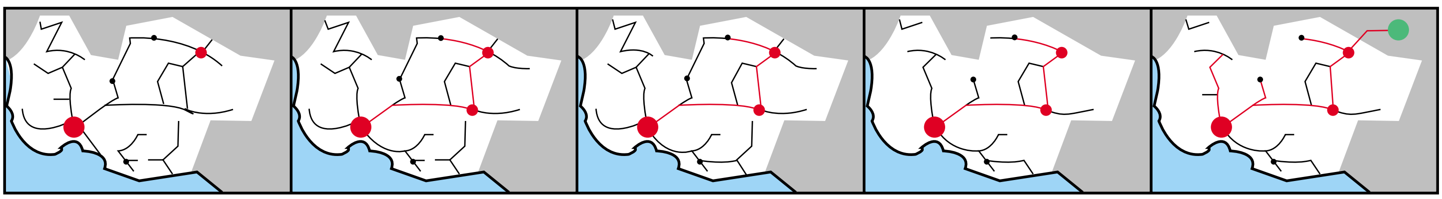


Fig.1. **Selection of reference networks in 5 stages. Method detailed in the SOURCE CD-ROM.**
In Africa, the reference networks defined by this method range from more than 10,000 (or even 15,000) km for jumbo-sized countries (such as Nigeria or South Africa) to less than 500 km for the smallest countries (such as Gambia, Djibouti or, naturally, the small island-states or archipelago-states).

SOURCE destination

For major networks in developing countries

This method, which has been validated for the typical landscape of major road networks in Africa, would not be suitable for groups of countries with much better road characteristics (the differentiation of road condition on the basis of common traffic speed declines significantly in quality for the top end of the range).

It is also important for a sufficient portion of the network under study to reach substantial traffic levels (the accuracy of macro-indicators is determined by the accuracy obtained over major routes). SOURCE is not suitable for aggregates consisting of rural earth roads only.

SOURCE is therefore a method specific to **trunk networks** in developing countries.

Area of validity

The SOURCE method is suitable for networks with the following characteristics:

Network structure

- *Few motorways or sections of more than 2 lanes*
- *Mixed paved / unpaved roads*
- *Mainly deteriorated condition*

Range of speeds

- *Common traffic speeds globally much slower than standard speeds in the West. Mostly below 90 km/h*

Range of traffic

- *Traffic levels usually low to very low compared with standard levels in the West. Mostly below 700 light vehicles per way and per day. But at least a few major road links exceeding 350 LVs per way and per day.*
- *Network far from generally saturated (except peri-urban areas).*

This is solely the limit of validity of statistical processes. This limitation of use does not mean that the general specifications of the monitoring tool are substandard.

On the contrary, great importance has been given to the conclusions and recommendations for road monitoring, given by PIARC (World Road Association, see particularly the work entitled HPMS – Highway Performance Monitoring Systems) to enable compliance with major specifications worldwide.

What information?

As an illustration, here are the results post-edited for the very first full-scale SOURCE measurement campaign conducted in March-April 1999.

Recap Sheet

GHANA — Country

Measured From Mar-99 To Apr-99

Consultant [illegible]

Controller [illegible]

After Traffic Rectification

SOURCE Ref.Network (Ranks 1 to 3) — 43 links

Gross Length	1027	Km	Dry season, business day, business hour
Rough %Paved	67%	%	
1-way LV Traffic Level	33	LV / h	
2-way LV Hourly Traffic Volume	256	x 1000 (LV x Km) / h	
LV Common Speed	69	Km / h	
LV Travel Speed	64	Km / h	
Travel / Common	0.9		

Standard Indexes

SOURCE [illegible] Paved: 257[illegible] · 100[illegible] · 48 · 247 · 7[illegible] · 7[illegible] · 1.0

Paved/U[illegible]

		Link Code	Min	Max	L1	L2	L3	L4	L5	L6	L7	L8
[1 to 4]		SOURCE Rank	1	4	1	4	4	4	3	4	4	2
		Road Classif.and Codes			N1	[illegible]	[illegible]	R120	[illegible]	[illegible]	R3	R134/R44
		Start			[illegible]	[illegible]	[illegible]	[illegible]	CAPE COAST	[illegible]	[illegible]	[illegible]
		End			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Characteristics	here just a visual survey	Overlay type			100% 0% 0%	100% 0% 0%	100% 0% 0%	0% 100% 0%	57% 0% 43%	100% 0% 0%	0% 0% 100%	84% 0%
		Carriageway width			39% 61% 0%	89% 11% 0%	100% 0% 0%	0% 100% 0%	0% 100% 0%	100% 0% 0%	0% 49% 51%	51% 32%
		Alignment type			6% 94% 0%	89% 11% 0%	0% 100% 0%	0% 100% 0%	30% 70% 0%	0% 100% 0%	0% 49% 51%	0% 84%
		Road condition			33% 67% 0%	84% 11% 5%	0% 100% 0%	0% 100% 0%	0% 100% 0%	100% 0% 0%	0% 49% 51%	51% 0%
Km		Gross Length	5	337	156	180	21	21	175	19	45	64
LV/h		1-way LV Traffic Level	0	183	117	27	43	12	16	92	18	47
(LVxKm)/h		2-way LV Traffic Volume	0	[illegible]	46,489	9,580	1,767	484	5,698	3,583	1,604	5,99[illegible]
mn		LV Travel Time	11	340	154	149	19	20	180	14	89	111
Km/h		LV Common Speed	28	[illegible]	61.9	73.7	65.3	62.5	68.0	80.8	58.2	63.[illegible]
Km/h		LV Travel Speed	34.7	97.[illegible]	64.8	72.4	64.6	62.7	58.3	81.3	31.3	34.[illegible]
mm-dd-yy	Measuring period	From			Mar-30-99	Mar-22-99	Mar-22-99	Mar-23-99	Mar-29-99	Mar-23-99	Apr-14-99	Mar-24
mm-dd-yy		To			Apr-10-99	Mar-23-99	Mar-23-99	Mar-23-99	Mar-30-99	Mar-23-99	Apr-14-99	Mar-24

Since this campaign in Ghana was part of the method development at the pre-consolidation step, it does not obey 100% of the rules of the final measurement protocol. Hence these results are shown here as specimens only.

Fig.2.
Characteristics and results for the 81 links of the network under study, some 6,400 km long. (extract)

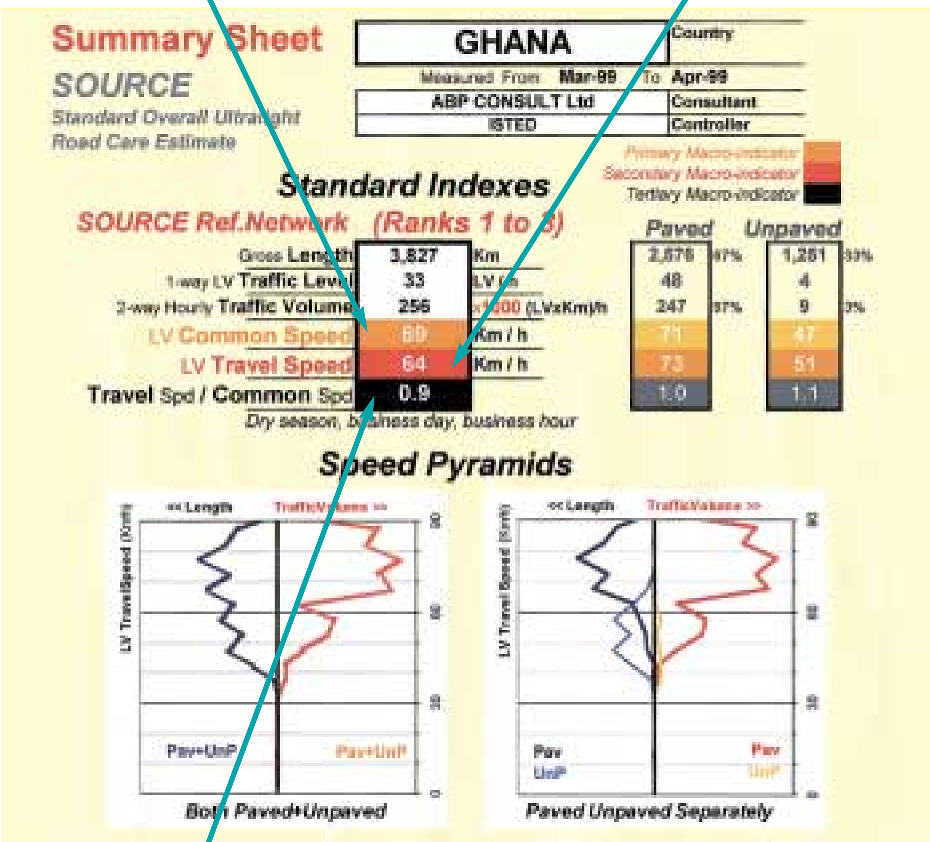
The macro-indicators

SOURCE indicators are national aggregates evaluated for the entire reference network of the relevant country. They apply to the dry season, for business times and days.

SOURCE primary indicator:
"common speed" *of LVs on the reference network. This indicator is calculated as follows: harmonic mean of LV speeds, measured section by measured section, weighted by hourly LV traffic volumes in both ways of travel.* ***This speed is said to be "common" because it is the most probable speed of a LV travelling on the network, chosen at random.***
This indicator is expressed in km/h.

SOURCE secondary indicator:
"travel speed" *of LVs on the reference network. It is the harmonic mean of LV speeds, measured section by measured section, simply weighted by the lengths of these sections.* ***This speed is called the "travel speed" because it is the resultant speed of a LV that has travelled once over the entire network, adopting the exact common speed as recorded on each section.***
This indicator is expressed in km/h.

Fig.3. **Examples of SOURCE graphic output: above, the network under study, below, the combined LV speed /traffic map.**



SOURCE tertiary indicator:
ratio of secondary indicator to primary indicator. This index relates to the homogeneity of the network situation. It requires careful interpretation.
Practically, for a country network, it is a number between 0 and 1.

Fig.4. **SOURCE summary sheet for Ghana (extract): macro indicators, network profiles and classes of service. The profiles compared by traffic volumes and lengths are sophisticated aids for interpreting the tertiary macro indicator, reserved for specialists.**

From one period to another, comparing costs and service gains

The SOURCE primary macro indicator is thus expressed as a speed (designed to be levelled off to 90 km/h). It breaks down naturally into two sub-indicators, for paved roads and unpaved roads.

Given the major roadwork program of the previous three years, the difference recorded on the SOURCE primary indicator can be divided into 3 cumulative differences, related to the corresponding budgetary flows:

- gain in speed due to new works,
- gain in speed due to periodical maintenance,
- loss of speed due to ageing of the network resulting from the climate and traffic but moderated by routine maintenance.

Thus globally, it is possible to obtain the direct economic balance of a medium and long-term road policy, by measuring the part of the profits attributable to each of its heavy components.

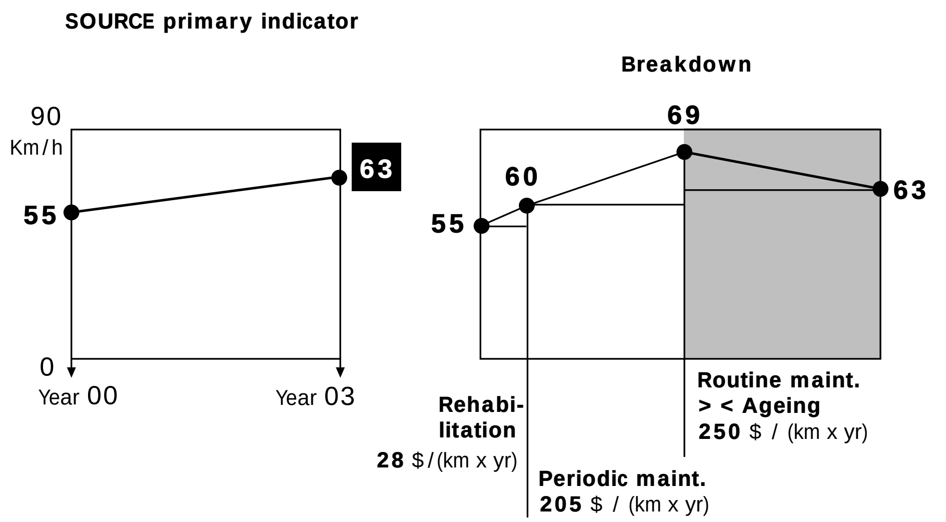


Fig.5. ***Breakdown principle of the intercycle difference of the SOURCE primary indicator. Note: here the budget flows are related to the km of the complete reference network, and not the km of works.***

The field test

Based on clear goals set at the end of 1997 in Lomé between RMI partners, the terms of reference of the SOURCE project were established early in 1998. The research and experimentation phase was entrusted to a multidisciplinary team, under the direct supervision of the RMI team, and which included: a coordinator also in charge of field test logistics, a scientific partner for the road engineering aspects, an expert for the economic and methodological aspects.
The first series of field tests was developed in four countries (Cameroon, Guinea, Ghana and Madagascar) for some 1,000 sample-kms per country, in July-August 1998. These tests were the core of the first phase, the conclusions of which were presented to donors and RMI African partners at the end of 1998 in Dar-Es-Salaam.

First test campaign over 4 countries

3,800 km of roads chosen in 4 countries were subjected to the following:

- exhaustive roughness measurements using a bump integrator,
- exhaustive multicriteria recordings of deterioration (VIZIR on paved roads, VIZIRET on unpaved roads), entered on DESY instrumentation,
- measurements of oncoming traffic both while travelling and from fixed facilities,
- measurements of common speeds, combining accurate exhaustive measurements and statistical measurements using 6 different protocols.

Nomber of roads links		Length km	Length %	Alignment [1,2,3] Slope	Alignment Bendi-ness	Traffic Veh/H LV	Traffic HV	Speed km/H LV	Speed HV	Condition Rough-ness IRI	Condition Deterio-ration rating
Unpaved	33	**961**	**25%**	**1.1**	**1.2**	**5**	**3**	**35**	**25**	**8.4**	**20% (1)**
Paved	122	**2811**	**75%**	**1.8**	**1.7**	**64**	**8**	**67**	**55**	**4.1**	**3.5 (2)**
Total	155	**3772**	**100%**	**1.6**	**1.6**	**49**	**7**	**65**	**50**	**5.2**	

Note1: the mean speeds are harmonic means weighted by traffic volumes (the arithmetic mean is in fact determined from the travel times).
Note 2: all the other means are arithmetic means, weighted by lengths.
(1) Unpaved, VIZIRET methodology: % of length affected by deterioration in rank 3: deformation, rutting or potholes.
(2) Paved, VIZIR methodology: overall rating of 1 to 7 (assessment data for severity and extent of deformation, cracking and repairs).

2nd stage: a measurement campaign in real conditions

In March 1999, a full measurement campaign in Ghana was entrusted to a third party service provider, a local engineering firm, under the supervision of the project coordination body. The main aim was to test in an operational context the aids, tools and training resources required to learn the SOURCE method, validate field costs and develop a quality control protocol applied to measurements (training of crews, certification, etc.). An enlarged network of 6,400 km was thus measured (the nominal "SOURCE reference network" is around 3,800 km).
The main lessons drawn from this experimentation, its unprocessed results and the prototype tools of the method were presented to donors and RMI partners at the end of April 1999 in Washington.
The consolidated budget for the SOURCE project, publication and distribution not included, but extensive field tests included, was below USD 350,000.

		Rank 1 to 4	Length km	Of which paved km	Of which paved %
GHANA Entire experimentation network	**SOURCE Reference network**	**1**	1128	1105	98%
		2	1621	1102	68%
		3	1078	367	34%
		Sub Tot [1-3]	**3827**	**2576**	67%
		4	2585	1111	43%
		Tot [1-4]	**6412**	**3719**	58%

Validation of the methodological choices

The SOURCE method was validated on the basis of two analysis criteria:

- The ability to produce **reliable, reproducible measurements,** particularly for measuring the common speed, in compliance with the initial specifications (cost, output, equipment level).
- **The relevance of the choice of common speed to reflect the road condition** on this scale in the range of road networks under study.

Validation of the measuring method

This work was performed by combining the use of a powerful, specially-designed tool of computer simulation together with the field test measurement campaign.

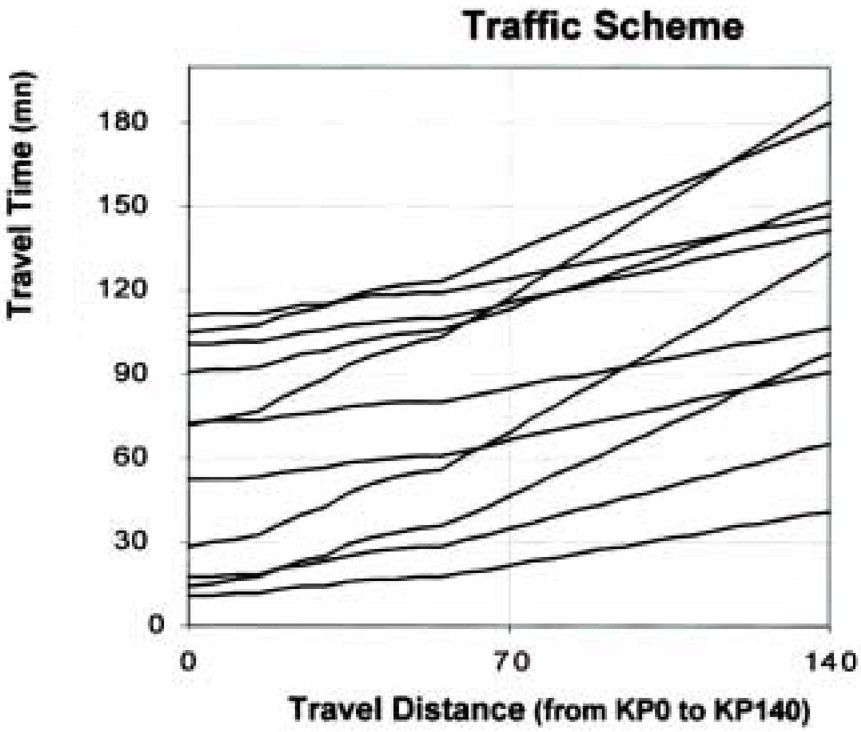


Fig.6. **Graphic representation of traffic.** Each line represents the path of a vehicle travelling on the road. The more the line tends towards the horizontal, the faster the vehicle. Where two paths cross on the graph, one vehicle is overtaking another.
Traffic is only represented here in a single way of travel. The oncoming traffic would give a second series of paths rising from right to left, not from left to right.
In fact, part of the real traffic does not travel the road over its entire length: junctions, branching off, stops or starts. Paths that begin and end along the way are therefore to be added.

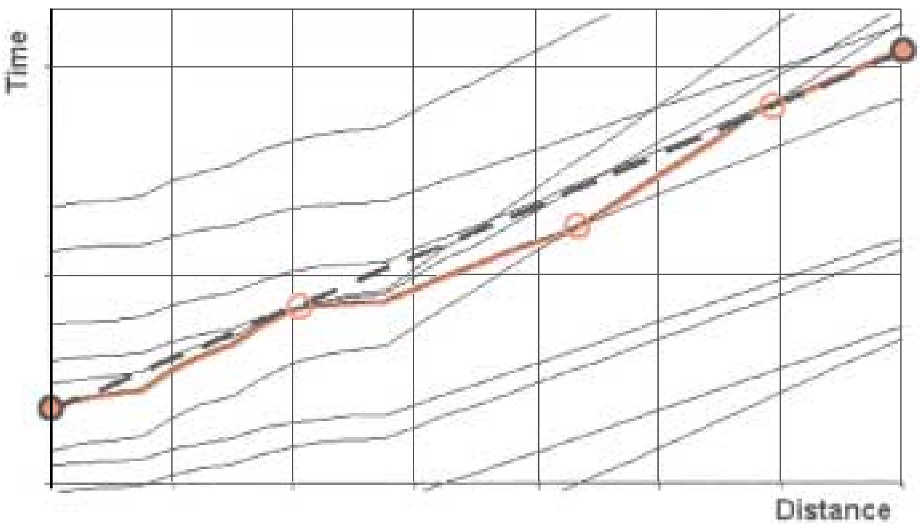


Fig.7. **Integration of floating vehicle (FV).** Here the FV (red path), “floating” in the traffic flow, has changed followed vehicle 3 times. The slope of its path (black dotted line) corresponds to its own mean speed over the trip path.
For sufficient (or correctly matched) distances and traffic levels, this physically achieves **very good statistical integration of the mean speed** of traffic (i.e. the harmonic mean of the vehicle travel speeds) in a much broader vicinity than just that of the sample of followed vehicles.

To measure common speeds, 6 measurement protocols were studied and tested: that of the "floating vehicle" and 5 "window" protocols. All these window protocols were based on: traffic "capture" within a closed area containing fixed and moving observers, then the reconstitution of the mean speed through the differentials between real traffic (perceived by the fixed observers) and apparent traffic (perceived by the moving observers).

These 6 protocols are symbolized by the opposite icons, which in each case present in diagram form the observation system integrated in the traffic flow.

All these protocols have been tested by computer simulation and field tests.

The floating protocol proved to be the most efficient by far in terms of quality of measurements. Again its tolerance ceiling and flexibility to traffic disturbances are the highest. Furthermore it is the most economic (in terms of productivity and resource mobilization).

A second series of computer simulations, more accurately parameterized on the basis of ranges and distributions recorded in the field, enabled still further fine-tuning of this protocol. After finalizing this protocol it was therefore used for the first full SOURCE measurement campaign developed on a large scale in Ghana.

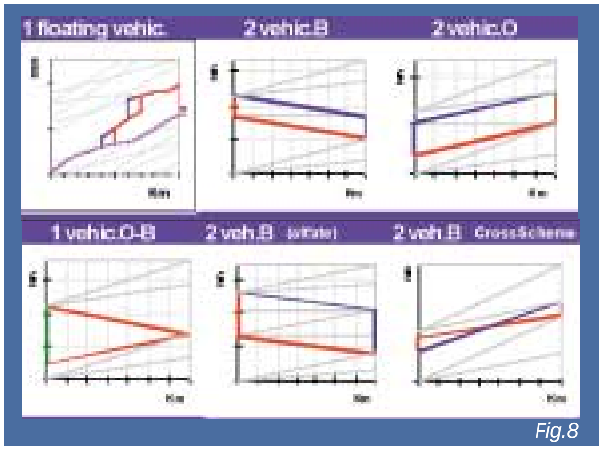


Fig.8

This experimental measurement campaign notably enabled testing of the field instruction manual, data input and processing tools.

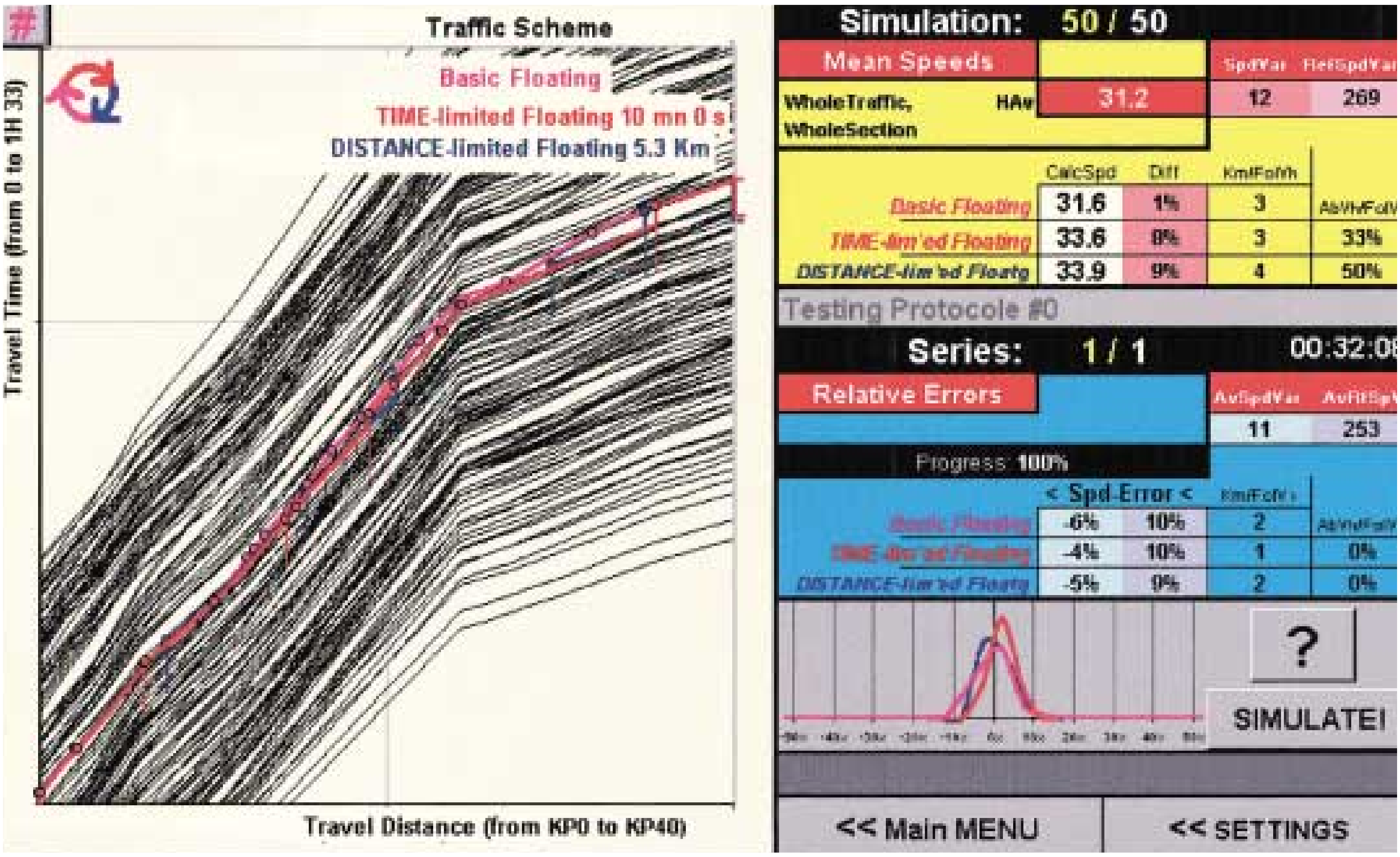


Fig.9. ***Display of a series of computer simulations of the micro-adjustment of the floating operation protocol.***

Validation of the choice of LV speed as a guideline parameter: speed-roughness correlations

This very conclusive work was conducted during the first test measurement campaign using conventional heavy, exhaustive methods (roughness measurement by bump integrator, visual multicriteria recordings) in conjunction with the speed measurements, in order to subsequently work on the correlations.

However, it is important to be aware of the limits of this work. The generalization of IRI for measuring surface roughness was the fruit of an extensive standardization quest, but it is not the perfect comprehensive index of road condition (which is why many competitive multicriteria methods, all fairly similar, are available). The SOURCE approach, on the other hand, gives special weight to the actual level of service of the road, more than its condition. The extent of surface deformation (roughness) is but one (major) component.

Paved roads

	LVmeansSpd		HVmeanSpd	
	R^2	**P**	R^2	P
All alignment types	**0.33**	**0.00**	0.06	0.01
Bendiness 1	**0.53**	**0.00**	0.26	0.00
Bendiness 2	**0.26**	**0.00**	0.00	0.68
Bendiness 3	**0.11**	**0.05**	0.01	0.62
Slope 1	**0.54**	**0.00**	0.30	0.00
Slope 2	**0.21**	**0.00**	0.00	0.88
Slope 3	**0.25**	**0.00**	0.09	0.13

2 indicators were used for each of the tests: the determination coefficient (R2) and the P-value (probability of making a mistake when assuming the correlation exists).

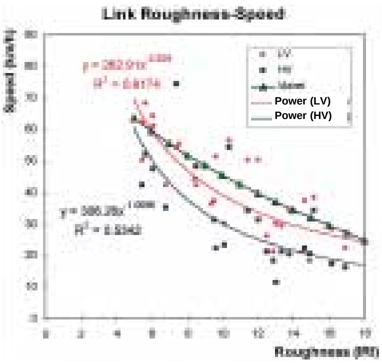
All alignment types

- Heavy vehicle (HV) speeds give much lower results than light vehicle (LV) speeds.

Stratification by alignment type

- The determination coefficients obtained for "good alignments" are thoroughly satisfactory.

Unpaved roads alone



Paved and unpaved roads

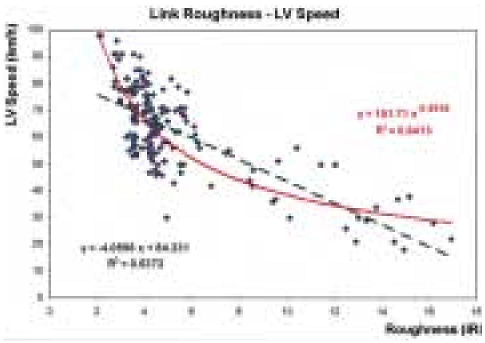


Fig.10/11. In these graphs, there are two trend lines: a linear regression and a power regression (the law used for HDM is of the type Speed = a x Roughness $^{-1}$).

The results obtained are encouraging:

- pertinent determination coefficients,
- power regression very close to linear regression,
- the power relation gives an exponent close to the –1 exponent of HDM literature.

As the entire paved/unpaved range is continuously taken into account, we obtain **an adjustment quality** very close to the good results obtained on unpaved roads alone.

SOURCE: the usual questions

Speed and safety: "A network performance assessment based on speed – isn't that undermining road safety?"

Not at all, because:

• It is the common traffic speed that is measured here, i.e. the range of speeds spontaneously adopted by a sample of drivers taken in ordinary conditions. The measurements do not influence their speeds. Quite the reverse as the whole art of measuring lies in not influencing the measured phenomena.

• The SOURCE method integrates the levelling off of speeds at 90 km/h. The floating vehicle is not allowed to exceed this speed. The top stratum of speeds of the samples is thus systematically erased. The SOURCE indicators neither give premiums to countries that become lax in their road safety policies nor penalties to countries adopting such policies.

Note: in view of the general conditions of networks and vehicles in the countries under study, the speeds encountered tend to be low (typical speed range in developed countries: between 80 and 150 km/h; typical range in Africa: between 15 and 90 km/h). Unfortunately this does not mean that speed has no effect on safety.

The index has no effect on high speeds and high speeds have no effect on the index.

Speed and... speed limits?

• The effect of speed limits, whether localized or generalized, on SOURCE measurements is mostly offset by levelling off at 90 km/h.

Speed and national profiles?

• The first series of national campaign measurements will enable rules to be established where necessary for correcting unprocessed speeds on a national scale, to erase the influence of national profiles (driving patterns, vehicle condition) based on control samples adjusted for surface condition and straightness. This national profile phenomenon, which proved marginal on first analysis, remains detectable, measurable and easily correctible.

Speed and alignment: "All right, speeds reflect road condition, but also its alignment. To what extent do you disregard or allow for the effect of the alignment on speeds"?

The actual level of service of a road is in fact mainly determined by 2 geometric road characteristics: its alignment straightness (gradients and bends) and its surface condition. Both of these factors directly influence the collective perception of comfort and safety and therefore the statistical distribution of free speeds.

• Problems where the alignment is a quasi invariate: historical series on the same stretch of road or the same network.

For a given route, except for very heavy work, the alignment is a perfect invariate (periodical maintenance or ordinary rehabilitation, by definition, do not change it).

Because of the scale of a given network, the overall straightness of the network is a fortiori a quasi invariate.

• Problems where the alignment is not a quasi invariate: country-to-country comparisons.

The vehicle category the most sensitive to the effects of alignment (lorries) is eliminated. As regards the effects on free speed of the gradient alone (slopes), LVs are practically unaffected.

The fact remains that for the same surface condition, 2 individual road sections, very different in straightness (gradient and bends), will therefore have different speed ranges, even for LVs. But in view of the final desired accuracy, we can consider this effect to be of minor significance on the first analysis, once it has been converted to the national index basis, i.e. entire networks.

Ongoing improvements:

***The availability of a universal LV Common Speed/Straightness abac** would make a whole series of minor precautions unnecessary, particularly for work on a small scale. The methodological prerequisites have already been met. We will be able soon to validate a SOURCE-type standard straightness index based on the kilometric frequency of visual "layout losses", that can consequently be efficiently measured in the field.*

*This straightness index has been introduced **on an experimental basis** into the permanent SOURCE system established in Madagascar (see further ahead), the tested objective being to obtain **an adjustment model for LV common speeds, based on the straightness scale.** The SOURCE speed for a given section could thus be systematically converted into a "straight, flat equivalent", a virtual speed purged of any effect of the alignment.*

A typical measurement campaign

Typical profile of a national measurement campaign

The "all-out" test conducted in Ghana has enabled the profile of a SOURCE measurement campaign to be visualized for an entire country.
Nearly 2 local teams measured 6,500 km during a field campaign lasting slightly less than a month.

Owing to adjustments to the method made since then (giving new gains in productivity), a nominal SOURCE campaign (reference network of 3,800 km) in Ghana would take around four weeks for a single team.

In Ghana, the overall productivity was 125 km of network measured per day and per team, unproductive periods included (rest days: + 20%).
The net productivity of a measuring team was already 150 km of network measured per day and per team for 200 km covered.

Frequency

It is naturally up to the client of a SOURCE measurement campaign to determine the network to be treated, depending on his own approach.
The SOURCE reference networks, which are essential samples on which to base cross comparisons, actually tend to correspond to the hard core of priority networks defined by the authorities in charge.

The ordinary periodicity recommended for SOURCE measurement campaigns on a national scale is one every three years. This corresponds to the recommendations of specialized bodies the world over and to standards in force in developed countries. And it is naturally consistent with the usual trend cycles of a major network.

Reference network trends

The initial SOURCE reference network, for a given country, from one 3-year period to the next, may change marginally (inclusion of new routes, upgrading or downgrading of some links -according to relevant criteria-, etc.). There will consequently be a simple exercise to update or verify the reference network before beginning a SOURCE measurement campaign.

How much?

Here again, the experience in Ghana provides a tried and tested basis for assessing direct field costs of SOURCE measurements.

At 2 USD per km, we attain the technical minimum level possible for any method based on surface travel over a network. This takes into account the terms of vehicle hire in Africa, which tend to be prohibitive.

Economic structure of the experimental measurement campaign in Ghana

Field costs	USD	USD **per net measured km**	***Initial estimates***
• 64 d hire 4-wheel drive with driver	7 040	1.09	1.23
• fuel (for 9,100 km)	1 067	0.16	0.26
• small items of equipment	350	0.05	0.05
• 64 d payroll + per diems	4 800	0.74	0.88
TOT	13 257	$2.04	$2.42

SOURCE development and by-products

Priorities for action

The strategy for distributing the SOURCE tool, now ready for use, has 4 priorities:

- **Launch the systematic observation system over the countries of Sub-Saharan Africa** to meet the widespread need for monitoring, expressed as much by donors as by countries and regional bodies.
- **Encourage recent or new Road Funds, Agencies or Road Administrations** of developing countries to adopt SOURCE as the main tool for monitoring results, primarily on an annual basis.
- **Disseminate the SOURCE method** to the engineering sector (international and local consultants: professional networks; training institutions; etc.).
- Set up **a SOURCE quality label** for measurement campaigns based on local initiatives (voluntary certification procedure under the external quality control method adopted).

The rolling observation system for Africa

According to the reference networks method, application to Sub-Saharan Africa (49 countries) would cover 134,000 km of main roads, (to be assessed systematically every 3 years). This large-scale reference network includes 41% of unpaved roads, the spectrum covered descending to traffic levels below 10 light vehicles per way and per day.

The system, thus consolidated throughout the continent, will naturally enable monitoring of super trunk roads **with a transnational potential**, a greater-than-ever challenge, that increasingly has to be tackled by bodies engaged in regional economic integration.

The next stage will thus be the launching of two 3-year monitoring cycles, including an optional part.

The monitoring system, which will be entirely subcontracted, will include 2 distinct assignments:

(a) general coordination of operations, full responsibility for the measurement campaigns and internal quality control.

(b) external quality control and further research (based on the fast-expanding body of field data).

The total target cost is USD 175,000 per year, averaging USD 10,900 every 3 years per country covered.

Sub-Saharan Africa SOURCE Observatory	3-year cycle over 48 countries	Annual phase (16 countries per year)	Volume for an average country (once every 3 years)
Length to be mesured	**134,000** approx **41% of which unpaved**	**44,700** on average	**2 800** Range: 150 km to 18,000 km
1. Measurement campaign costs (field costs)			
Hire 4-wheel drive + driver	**$131,000**	**$44,000**	**$2,750**
Fuel + maintenance	**$22,000**	**$7,300**	**$460**
Payroll + per diems	**$100,000**	**$33,100**	**$2,070**
Sundry costs	**$15,000**	**$5,000**	**$310**
Sub-Total 1 :	**$268 000**	**$89 400**	**$5 600**
i.e. per measured km	***$2.00***	***$2.00***	***$2.00***
2. Measurement campaign costs (consultancy costs)			
Local coordination & engineering	**$116,000**	**$38,700**	**$2,400**
Sub-Total 1+2 :	**$384 000**	**$128 000**	**$8 000**
3. Non-campaign costs, external costs			
External supervision and quality control	**$115,000**	**$38,300**	**n.a.**
Additional costs, distribution, methodology, etc.	**$26,000**	**$8,700**	**n.a.**
TOTAL 1+2+3	**$525,000** over 3 years	**$175,000** In annual phase involving16 countries	**$8 000** Once every 3 years
i.e. per measured km	***$3.92***	***$3.92***	***$2.87***

Note: All figures rounded except unit costs.

This table illustrates the budget of such a system (a virtual observatory, with no need for a permanent structure).

This is only a model. Many aspects are not addressed, among which, the substantial reduction of the distance necessary because of hazardous areas. *Note simply that 40% of the surface area of the African continent is considered to be affected by disorders such as war or civil war. Anyway in all of these areas, road assessment, at all events assessment by the SOURCE method based on actual traffic, would be meaningless.*

Adapting to specific problems

The SOURCE method is flexible enough to adapt to specific problems.

More intense monitoring than the three-yearly rhythm may be required in certain cases. Special needs may entail a frequency of one measurement campaign per year, for instance to provide objective progress indicators to implement a reform of the national road maintenance and management policy. Road Funds, Agencies or Road Administrations in some countries will benefit from adopting SOURCE as their main network performance monitoring tool.

Still more accurate monitoring of change on a single major road link (or a specific sub-network, e.g. the aggregate portion treated under a rehabilitation program) is also possible by the SOURCE method. Below the threshold of 150 km in length, we simply obtain the standard quality of results by multiplying the measuring runs accordingly.

An exemplary system:

The Ministry of Public Works of Madagascar now applies SOURCE every fortnight, using a slightly adapted measurement protocol, so as to monitor changes, mainly season-dependent, in common travel times and traffic levels on the country's three ultra-priority routes, a total length of around 1,850 km.

This work is conducted on their return trips by the 3 specialized Ministry of Public Works watch patrols. On their outward trips, every fortnight for the last 6 years, at a rate 5 to 7 times slower, these patrols have been recording, marking out and warning the subdivisions of all new damage and ensuring it is addressed within the time limits established by a quality charter. ***The two tools complement each other.***

An everyday tool: the simplified method

For daily network monitoring by the front-line manager, it is possible to derive more summary methods from the SOURCE method, which yield direct in situ estimations of common speeds and common traffic levels over a given route, made "on the move", without any special preparation or training. In this case, the aim will be to determine rough orders of magnitude, for guidance only, which will characterize the pattern of change of a given road link (whatever the season). This information is precious and virtually free of charge, but without actual statistical quality. It has nothing to do with SOURCE standards.
But the spirit of these methods remains in line with the SOURCE method: summary information, immediately available and accessible to everyone, of limited but controlled value, rather than maximum information, never available or never reliable.

For instance:

Assessing the level of traffic while "on the move"? It's easy...

For 10 mn, count the light vehicles (LV) you encounter travelling at a normal speed. If the total is N, the order of magnitude of the daily LV traffic in both ways on this section is 80 x N (in LV/day). (see rationale on the SOURCE CD-ROM)

And if you yourself are travelling according to the "floating vehicle" principle in the simplified version, this assessment is already greatly improved.

The SOURCE Toolbox: a free CD-ROM

The following basic tools make up the SOURCE "toolbox". In addition to methodological papers, specialised reports and some helpful reference documents, the SOURCE CD-ROM includes English and French versions of:

• The SOURCE Handbook, with the following models in annex:
- **Section Data Sheet,**
- **Data Page,**
- **Calibration Sheet.**

The SOURCE handbook also exists as a half-size format file (A5) consisting of strong, practical thumb-index cards, designed to remain permanently in the storage tray of the measuring vehicle throughout the measurement campaign. This file is for restricted distribution.

• A reference network graphic and display software: the SOURCE map editor

This software for Excel includes a full library of SOURCE reference network data for the 48 countries of Sub-Saharan Africa. It enables any specific network to be adapted or created easily from simple previously scanned road maps.

• The SOURCE data processing spreadsheet

For Excel. The results once processed can be reintegrated into the map editor to produce standard maps illustrating network-wide speeds and traffic, as hard copies or electronic versions (the electronic versions can be consulted simply by clicking).

These tools are free of all rights of use and reproduction for all purposes subject to the detailed limits in the CD-ROM documentation. These tools in the designated forms may only be distributed free of charge, except for postal charges and reproduction costs where applicable.

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Zooming in on the SOURCE Handbook

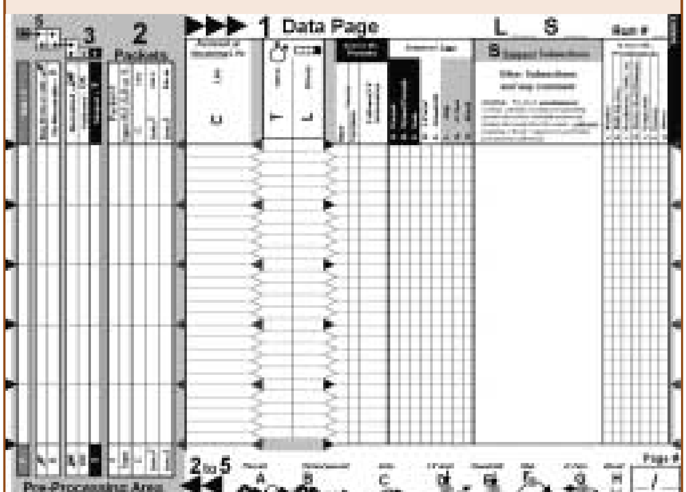
This manual, which has been field-tested for good pedagogical quality, is intended for the measurement campaign coordinator who must have a thorough working knowledge of the contents, and for each crew leader who must assimilate it well and be able to refer to it.
It is designed to be available at all times in the vehicle during the measurement campaign, to check a point in the method, resolve a hard case or illustrate an explanation given to the driver by the crew leader.

It gives a full upstream-to-downstream description of the method, with the corresponding support tools. Besides the basic principles and minimum theoretical background, it gives the successive phases of a SOURCE national measurement campaign, with all useful instructions. It includes three parts:

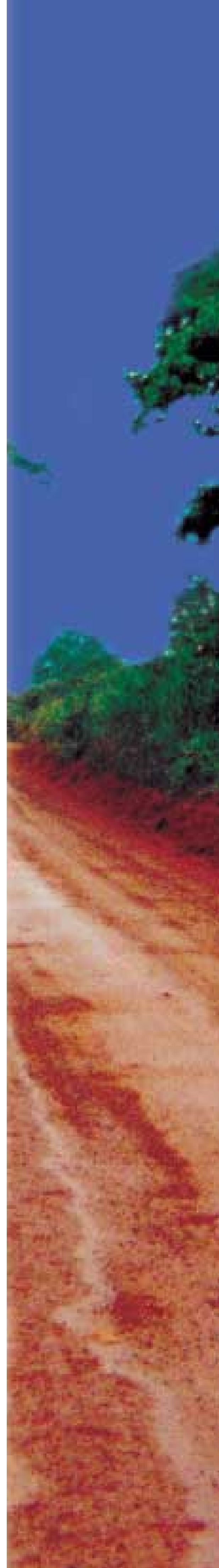
*• **Measurement campaign preparation:** drawing up the campaign plan / crew training and practice / external quality control requirement / calibration plan / crews and logistics.*

*• **Field measurements:** general measuring principle / crew and users / basic protocol / difficulties connected with vehicle pursuit, trip path and road / traffic conditions / weather conditions / logical method for taking disturbances into account / pre-processing of measurements / measurements to be repeated.*

*• **Desk data processing:** prior control and validation / computerized processing / data transfer / calculations and review / outputs.*



Examples of SOURCE graphic outputs: above, the network under study, below, the combined LV speed/traffic map.



SOURCE: Floating operation method

Refer to the SOURCE Handbook for condition requirements, detailed rules, instructions for use of data input forms and limits of validity of results.

Summary

Merge into the traffic, following a first light vehicle (LV). At the first opportunity (as soon as another LV overtakes you – a hare – or the followed LV overtakes another LV – a tortoise -), change followed vehicle. And so on all along the trip path.

This operating method makes you a "floating vehicle", which means that providing the traffic remains free-flowing over a sufficiently long trip path, your own travel time will be a direct statistical estimation of the mean LV travel time.
This mean travel time is the most meaningful indicator for users. The expert, on the other hand, will prefer to reason in terms of the corresponding speed ("common" speed).

Four further driving rules are added to this basic protocol, to improve the quality of the results:
a. mandatory hare-tortoise alternation,
b. compliance with the 90 km/h speed limit,
c. limitation of basic sequences to 15 mn,
d. degressive waiting times where there is no traffic.

At the same time you count the apparent light vehicle traffic coming in the opposite direction.

As your speed is adjusted to the common LV speed, the apparent LV traffic level is exactly twice the real traffic level (the level that would be perceived by a stationary observer).

1 The basic protocol

• **Only work in the dry season, during business days and times, but not in bad weather.**

• Your direction of travel is of no importance.

• Your speed results from the protocol itself.

• **Only take "light vehicles" (LVs) into consideration.** Disregard all other vehicles, such as lorries (trucks) or two-wheeled vehicles.

• **And now, proceed as follows:**
With your kilometric recorder set to zero, **start off behind the first LV** coming up in the right direction, while triggering the timer.

Then, **when you encounter a new LV travelling in the right direction**, change "partner" (i.e. followed LV) while noting the time and kilometerage.
Each "pursuit" is made while maintaining a reasonable distance (usually 50 metres). You must not worry the followed LV driver nor influence his behaviour, but neither must you lose him.

This is the basis of the floating operation method.
But in fact, things are rather more complicated.

2 The 4 additional rules

2a. "Hare-tortoise" alternation rule

You must follow in turn a tortoise then a hare. Never two hares or two tortoises in succession.

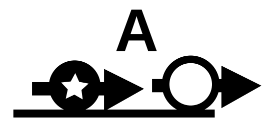
A tortoise is a LV being overtaken by the LV you are following.
A hare is a LV coming up to overtake it.

The first followed LV is considered neutral (neither a hare nor a tortoise). The second followed LV will be either a hare or a tortoise, depending on whether this LV has overtaken the neutral vehicle or the neutral vehicle has overtaken the LV.

When you are following a tortoise, if the followed tortoise is overtaking a super-tortoise, disregard the super-tortoise because you are looking for a hare (likewise for super-hares if you are already following a hare).

3 The 8 types of sequence

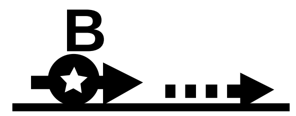
At all times along the trip path, a sequence is in progress. The sequences, whether the same or different in type (among the 8 types recapped here), succeed one another as far as the end of the trip path.



Pursuit

You are following a tortoise, a hare or a neutral LV.

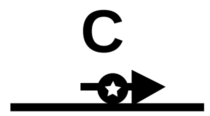
Max: 15 mn



Virtual pursuit

You had to let an excessively fast LV go. You are now only following a virtual LV travelling at 90 km/h.

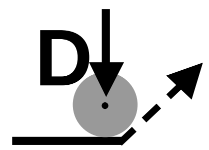
Max: 15 mn



Solo

For lack of traffic, you are travelling alone, without following anyone, at the most appropriate speed.

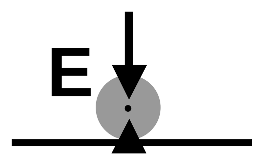
Max: 15 mn



LV Wait

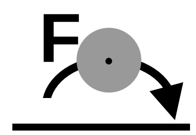
Ready to start, you are waiting for the next LV to be followed.

Max: 15 / 10 / 5 / 5...



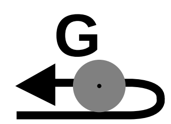
Standstill

You stop and pass the time until proper measurement conditions are back.



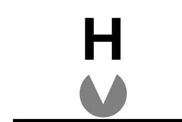
Skip

You suspend the measurement while continuing on your way until you meet proper measurement conditions again.



U-turn

After stopping the measurements, you return to a given point to re-start measuring (immediately or after a standstill).



Break period

After stopping the measurements, you do as you like until you start measuring again at the stopping point.

4 Traffic counting

Traffic counting and speed measurements go together.

The speed measuring operation is only active during the first three types of sequence.

★ As long as the speed measuring operation is active (type A, B or C sequence), the oncoming LV traffic is counted simultaneously.

● As long as the speed measuring operation is inactive (type D, E, F, G or H sequence), there is no counting of traffic.

5 Treatment of disturbances

It is the "free speed" of LVs that we want to measure, i.e. their spontaneous speed on this route as it is, in free-flowing traffic, without any extraneous disturbance, such as bad weather, traffic close to saturation or other incidents. We also want the traffic level to remain representative, i.e. also free of any disturbance.

Any disturbance encountered, that affects speed or traffic levels, or both together, makes the measurements suspect (liable to be invalidated). You could then perform a skip (to travel farther ahead so as to outstrip the phenomenon), or come to a standstill (to pass the time until the phenomenon disappears)

The different situations and the corresponding instructions are described in the SOURCE Handbook.

Hare, tortoise or neutral vehicle...
how does a pursuit end?
Usually with the start of another pursuit.
TWO ORDINARY CASES at first:

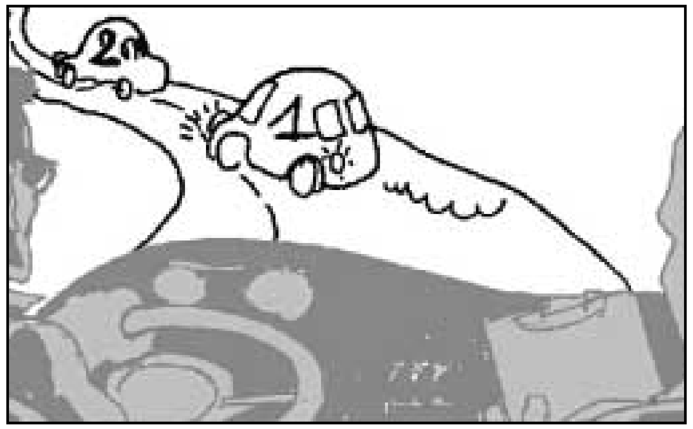
How does a pursuit end? 1st ordinary case:

You were following a hare *(LV No.1).*
It catches up with a tortoise *(LV No.2).*
It is very simple: whether or not the hare overtakes the tortoise makes no difference. As soon as the hare gets close enough to the tortoise to overtake it, "forget the hare". It is the tortoise that you must now follow.

Which logically means that:

- If the hare (No.1) actually overtakes the tortoise, immediately or after a while, do not overtake because it is the tortoise (No.2) that you must now follow.
- If the hare follows the tortoise without overtaking, you must also follow. It is the tortoise that you are following, even though at a distance for the moment.
- If the hare (No.1) finally lets itself be outdistanced, overtake the hare so as not to lose the tortoise (No.2), which is the vehicle you are following.

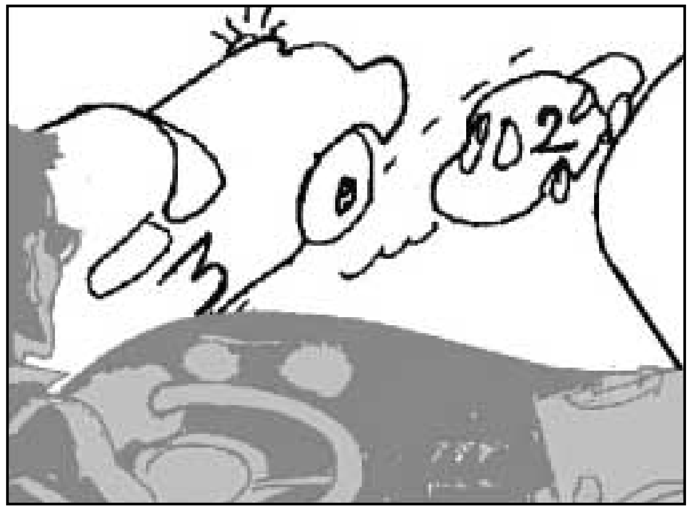
Idem if LV No.1 is a neutral vehicle instead of a hare.



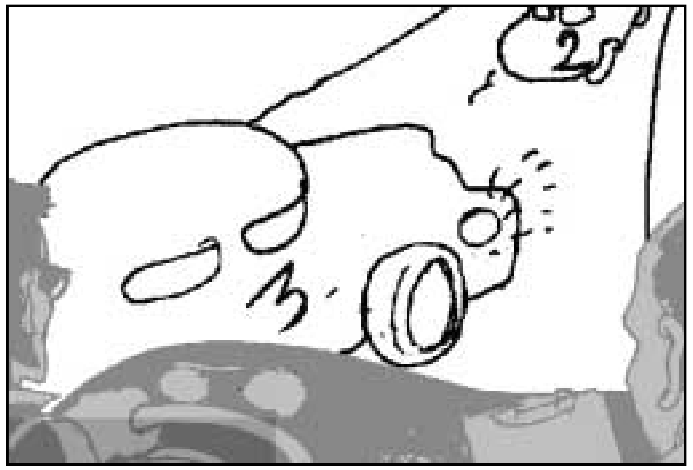
In other words: **A tortoise counts as soon as it is caught up, even before it is overtaken by a hare (or a neutral vehicle).**

How does a pursuit end? 2nd ordinary case:

You were following a tortoise *(LV No.2)****. A hare*** *(LV No.3)* ***catches you up.***



- **If the hare overtakes both of you at once, it is very simple: overtake the tortoise (No.2) in turn** so as not to lose the hare (No.3), as it is the hare that you are now following. "Forget the tortoise".
- **But if the hare comes in** between you and the tortoise for a while, then:



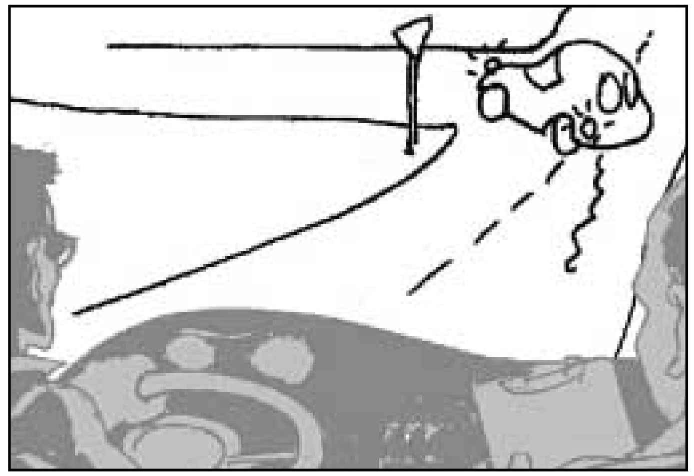
- **As long as it has not also overtaken the tortoise,** do not change anything. Although you are now separated from the tortoise, it is still the tortoise you are following.
- **If in the end, it also overtakes the tortoise,** then "forget it". It is now the hare you are following. Therefore overtake the tortoise likewise.
- But if after coming in between, **the hare finally lets itself be outdistanced by the tortoise,** then overtake the hare to remain close behind the tortoise. This hare will never have counted for you. Now you must look out for the next hare.

Idem if LV No.2 is a neutral vehicle. Instead of a tortoise.

In other words: **A hare does not count until it has overtaken a tortoise (or a neutral vehicle).**

How does a pursuit end? A special case:

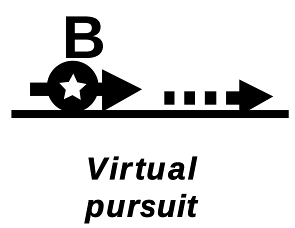
If the LV you were following parks or turns off the road.
Stop just afterwards, noting the time and kilometerage. Wait. As soon as the first LV passes in the measuring direction, move off after it. In fact, you are taking up the interrupted measurement again and the stopping time will not be taken into account in the end.
This first LV will then be considered as a neutral vehicle.



How does a pursuit end? Two more cases...

The following two rules cover other special end-of-pursuit cases.

2b. The "90 km/h" rule



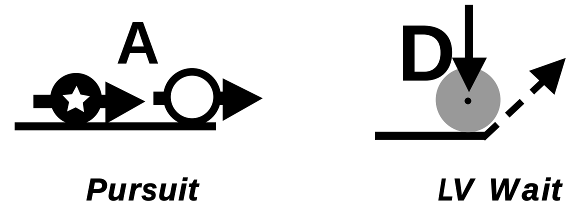
Your own speed is limited to 90 km/h.
If you are supposed to be following a LV travelling continuously at more than 90 km/h, or if the followed LV accelerates and sustainably exceeds 90 km/h, you must let it get away and continue your route alone, limiting your own speed to 90 km/h. This has become a "virtual pursuit".

Then behave as if you were following a phantom LV travelling at a speed of 90 km/h. This "virtual LV" retains the status (neutral vehicle, hare, tortoise) of the LV that has got away.

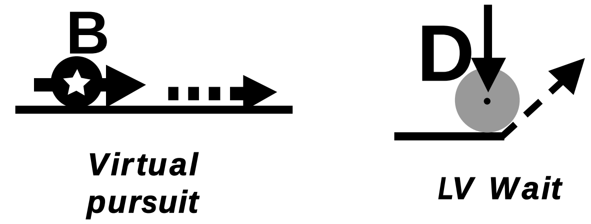
2c. The "15 mn" rule

Basic sequences (pursuit, virtual pursuit, solo, LV wait) are limited to 15 mn.
In the event of very light traffic or no traffic:

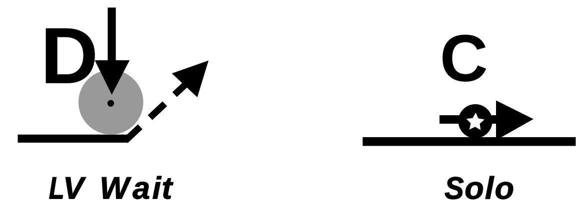
- *If you have been following the same LV for 15 mn at a stretch, (because you have not encountered another LV to follow that meets the hare-tortoise criteria):* ***you must stop at the end of the 15 mn*** *and let it go, to wait for the next LV. This is a sequence of "LV wait".*



- *If it is a "virtual LV": in these 15 mn, count the pursuit time of the LV that got away just beforehand.*

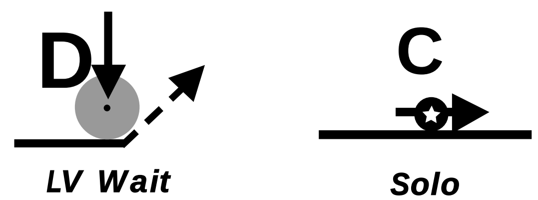


- *When you have been waiting 15 mn at a stretch without any LV to follow: start off again "solo", namely alone, at the most natural speed for an ordinary LV taking into account the condition and characteristics of the road. When running "solo", you must never exceed 90 km/h (see 90 km/h rule). At the first LV encountered, this "solo" sequence gives way to a pursuit. Where no LV is encountered, the sequence must be interrupted after 15 mn to observe a new "LV wait".*



2d. The rule of the "15 / 10 / 5 / 5..."

Your "LV wait" sequences (waiting for the 1st LV to be followed) are also subject to a degressive time limitation: 15 / 10 / 5 / 5 / 5 / etc.
When there is no traffic in the measuring direction, your travelling pattern is thus as follows: ***15 mn waiting*** *– 15 mn solo –* ***10 mn waiting*** *– 15 mn solo –* ***5 mn waiting*** *– 15 mn solo – 5 mn waiting - etc. This succession of wait / solo / wait / solo is interrupted as soon as the first LV comes up in the right direction, which triggers a conventional pursuit sequence.*
If this LV remains the only vehicle, let it go after 15 mn (see the 15 mn rule) and begin a new series: 15 / 10 / 5 / 5 / 5 / etc.



Adopting SOURCE: decision check-list

1 Advisability

1.1. SOURCE? Or not SOURCE?

- **Context? Requirements?**
- Internal **initiative**? Or request from a "partner" or a "client"?
- **Critical inventory** of present network monitoring or management tools:
  - ➨ For each data base, or for each critical item of information:
    - Field of use?
    - Effectiveness?
    - Covered network?
    - Updating frequency?
    - Exact uses: Overall performance monitoring / strategic guidance / Pre-programming / programming / routine maintenance guidance?
    - Tool management agency?
    - Quality/reliability?
    - Cost?
    - "Clients"?
  - ➨ Overview:
    - Centralization and consolidation of tools?
    - Gaps, inconsistencies and overlapping?
- Does SOURCE meet an unsatisfied critical requirement efficiently?
- **What place** does it have in an overall monitoring and management instrumentation system?
- **What place** does it have in a strategy to progressively improve the monitoring and management method?
- Is there sufficient consensus on **the cost-benefit ratio?**
- In what specific **context** does this favourable appraisal take place: heavy medium-term program? Reform? Introduction of a new player?
- And moreover, who is willing to provide funding, within what framework, subject to what constraints? On a "one-time only" or recurrent basis?

1.2. Aims? Targets? Particular specifications?

- For the account of **whom**? To assess the efficiency of **whom**? To account for **what**, to **whom**?
- **What direct, immediate uses** will be made of the SOURCE products:
  - ➨ Operators' reports to "shareholders"?
  - ➨ Dialogue between partners?
  - ➨ Dialogue with users?
  - ➨ Information to the general public?
  - ➨ Monitoring of a special policy or the efficiency of a reform?
  - ➨ Direct linkage with technical survey tools?
- Does the information generated by SOURCE **meet** the initial requirement? part of the requirement?
- **What network** is to be treated? administered by one or more road agencies?
- Useful frequency, technically and politically?
- In view of this framework and these specifications, will we manage to maintain the SOURCE **quality standards**? Are we **within the area of validity** of SOURCE?

2 Configuration

2.1. Responsibility line?

- Who will be **responsible**? Who will act at the various levels?
- Role distribution?
  - ➨ The responsibility of the different tasks, namely:
    - Operation and spreading
    - Permanent management of the monitoring tool
    - Management of the measurement campaigns
    - Internal quality control of the measurement campaigns
    - External quality control

    … should not be mixed up. It has to be separated from the responsibility of road maintenance operations. Is it the case? Is the division strong enough to prevent conflicts of interest?
  - ➨ If the intention is not to entrust the execution of the measurement campaigns to private service providers, **why? what advantage and for whom?**

2.2. Operational system?

- **Definite frequency?**
- **Volume** requirements of measurement campaigns: how many coordinators and measuring teams? What budgets and at what frequencies?
- In the light of the specific aims and constraints (time, resources, efficiency, season) must **adjustments** to the method be considered?
- Do these adjustments impair **the quality standards**?

2.3. What associated quality control system or systems?

- If the intention is to do without external control, **why? what advantage, for whom?**
- **Finally,** what controls, at what levels and by whom? accountable to whom?
- Will the internal and external control systems be in a **position** to reject bad quality, where necessary?

3 Routines

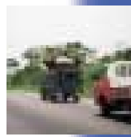
3.1. Training requirements and resources?

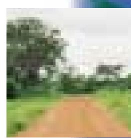
- Initial training (certification system?)
- Refresher training for each measurement campaign?

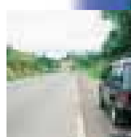
3.2. How do we acquire the means to re-assess this system and enable it to progress?

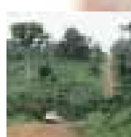
This check-list, for indication only, recapitulates the questions to be addressed when introducing SOURCE into your network management system.

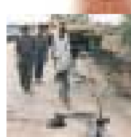
This could also give a good starting point in any collective workshop for questioning the entire management system.

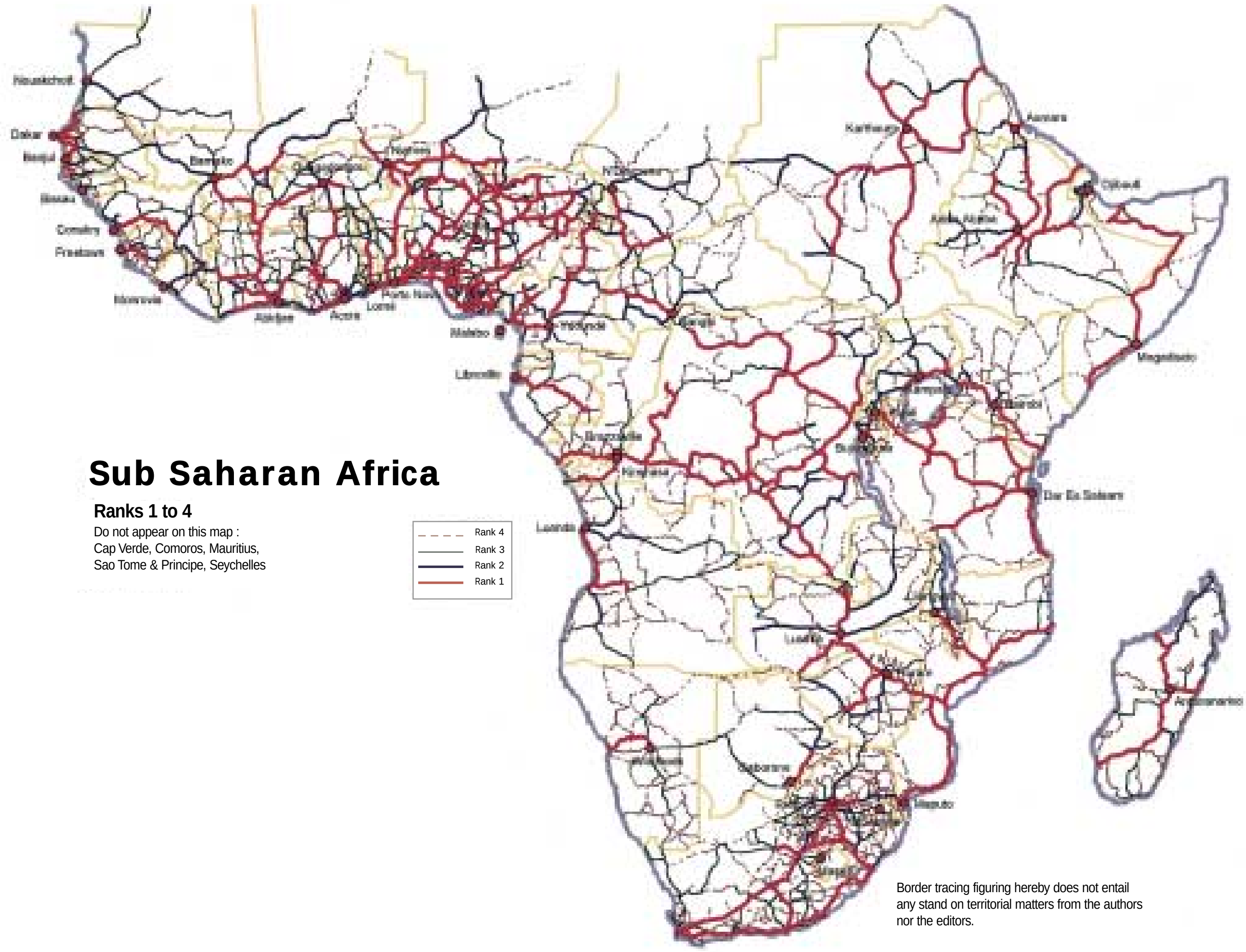












Assembly of the SOURCE Reference Networks for Sub-Saharan Africa (with all Rank 4 s in addition).

Acknowledgements

This comprehensive document is the result of joint work
developed over a period of nearly three years under the SOURCE project.
The SOURCE project was initiated and conducted by the RMI (Road Maintenance Initiative),
a SSATP component (Sub-Saharan Africa Transport Policy Program), which is a joint program
administered by the World Bank, in conjunction with road sector donors and RMI partner countries.
The SOURCE project has been piloted by Louis Fernique.

Our deep appreciation goes to:
• Road Administrations in the host countries of the experimentations:
The Ministry of Public Works of Cameroon, the Ghana Highway Authority,
the Ministry of Public Works of Guinea and the Ministry of Public Works of Madagascar.
And to partners and contributors who have collaborated to fulfil the project:
• ISTED, in charge of coordination: Jean-Philippe Lanet and Guy Poirier
• The Laboratoire Central des Ponts et Chaussées (Central Road Research Laboratory) / International Studies and Research Department (LCPC/SERI): Paul Autret, Pierre Joubert and Claude Massonpierre, and technicians from the Regional Road Research Laboratories: Marc Dumesnil Adélée, Jean Lefebvre and Yves Raynaud
• Benoît Ninnin, consultant, transport economist

and:
• Trainees from the École Nationale des Ponts et Chaussées (ENPC) working in the World Bank, AFTT2 (Africa, Transport): Seddik Spiga, Antoine Asfar and Salim Bouzebouk
• Trainees from the École Nationale des Travaux Publics de l'État (ENTPE) working in ISTED: Charlotte Antoine, Alexandre Breuil, Julien Langlet and Julien Neltner

and a special mention to:
• ABP Consult Limited, in Accra, Ghana, who carried out the first large-scale experimentation under the direction of J.B. Asafo-Boakye.

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November 2000

Design - Creation: CariocA 01 55 21 20 80 - Photographer's Credit: ISTED