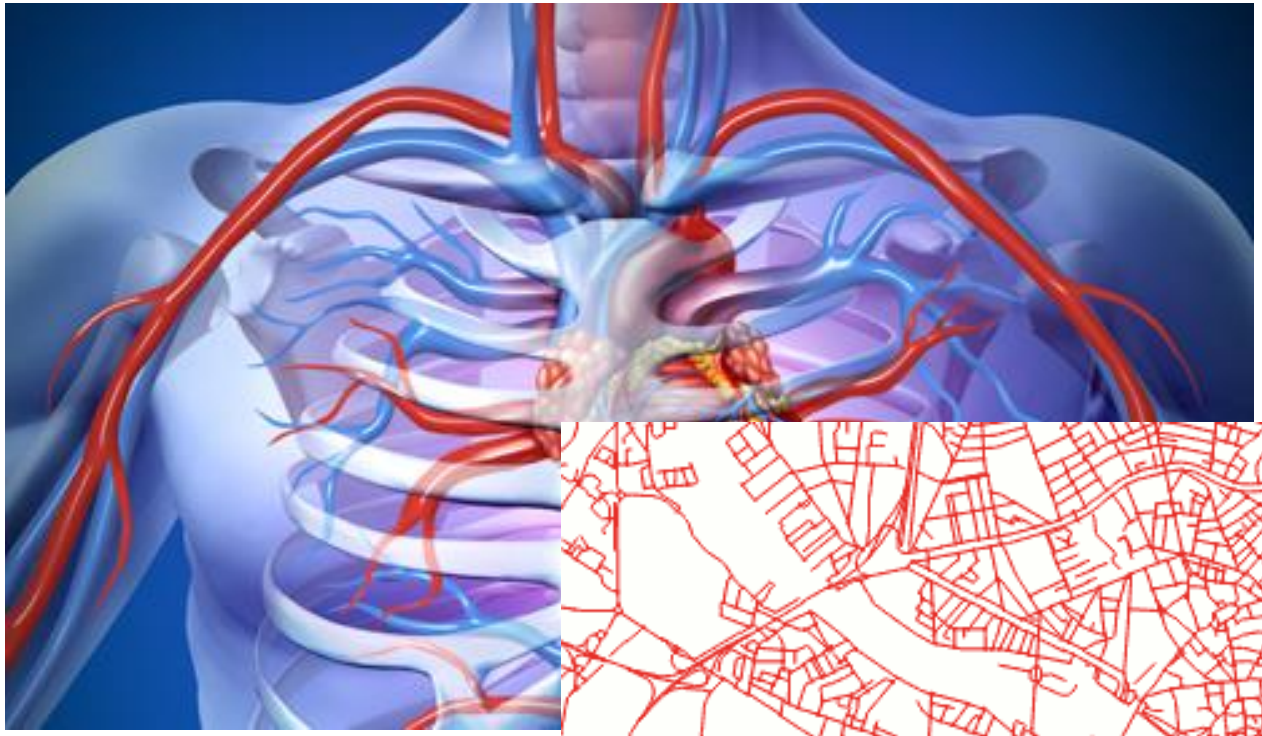
Pavement evaluation – an international perspective: Fit for purpose?

Richard Wix, ARRB Group

Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia

Roads – the arteries of a nation



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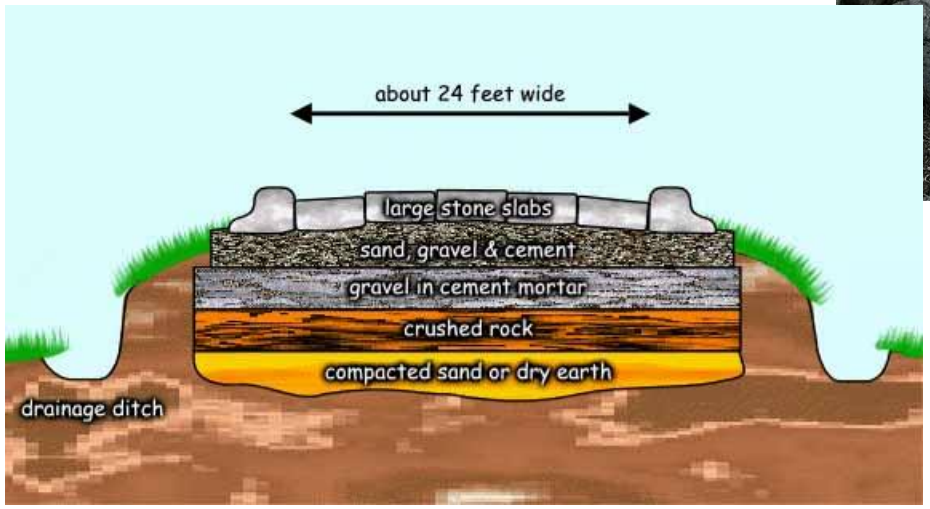
‘All roads lead to Rome’

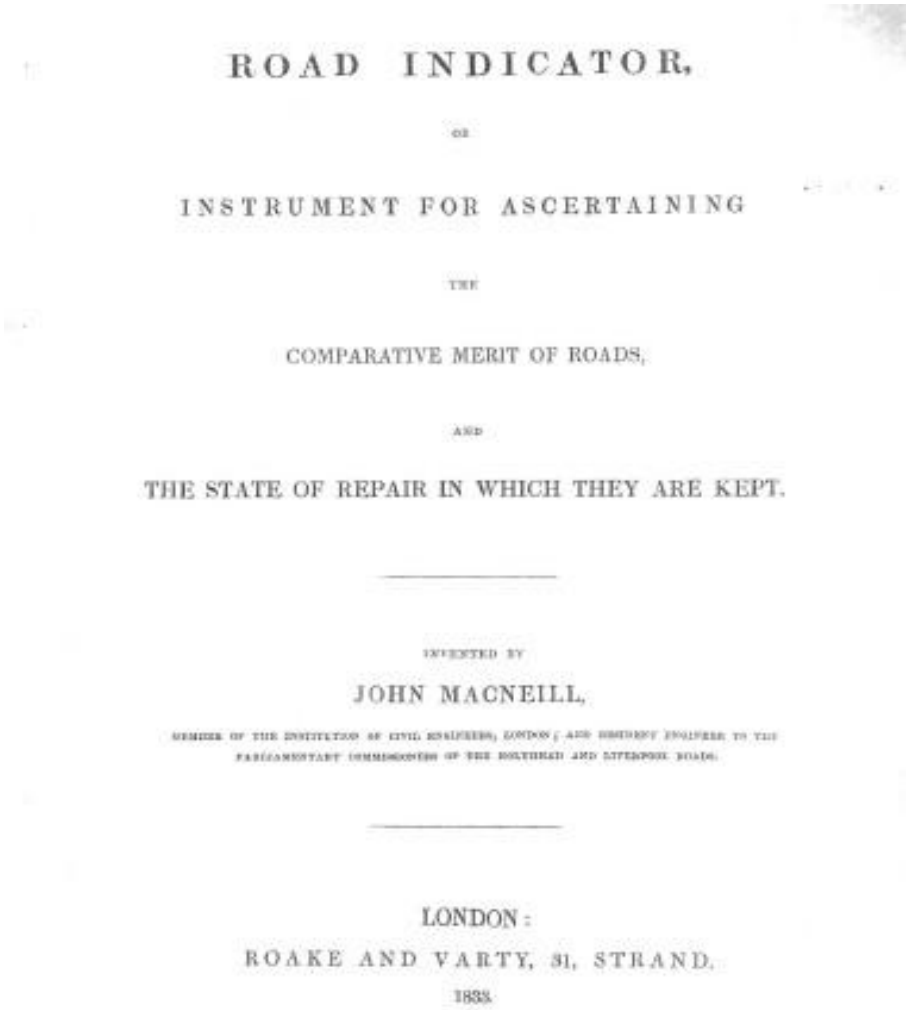
- Roads have always been important
- Romans built roads that lasted



http://www.crystalinks.com/romeroads.html

Appian Way today

Early pavement evaluation



ROAD INDICATOR,

OR

INSTRUMENT FOR ASCERTAINING

THE

COMPARATIVE MERIT OF ROADS,

AND

THE STATE OF REPAIR IN WHICH THEY ARE KEPT.

INVENTED BY

JOHN MACNEILL,

MEMBER OF THE INSTITUTION OF CIVIL ENGINEERS, LONDON; AND RESIDENT ENGINEER TO THE PARLIAMENTARY COMMISSIONERS OF THE HOLYHEAD AND LIVERPOOL ROADS.

LONDON:

ROAKE AND VARTY, 31, STRAND.

1833.

Road indicator (1833)

THIS Instrument is capable of being applied to several very important purposes in road engineering, amongst which are the following,

First, It affords the means of ascertaining the exact power required to draw a carriage over any line of road.

Secondly, It can be applied to compare one line of road with another, so as to determine which of them is the best, and, the exact amount of the difference, as regards horse power, both for slow and fast coaches.

Thirdly, The comparative value of different road surfaces may be determined with great exactness.

Fourthly, It affords the means of keeping a registry, in a most accurate manner, from year to year, of the state of a road, showing its improvement or deterioration, and the exact parts in which such improvement or deterioration have taken place.

Pavement evaluation 2014

Theme:

- Right measures?
- Right quality?
- Right analysis?
- Right quantity?
- What is the benefit?

What's going on in.....

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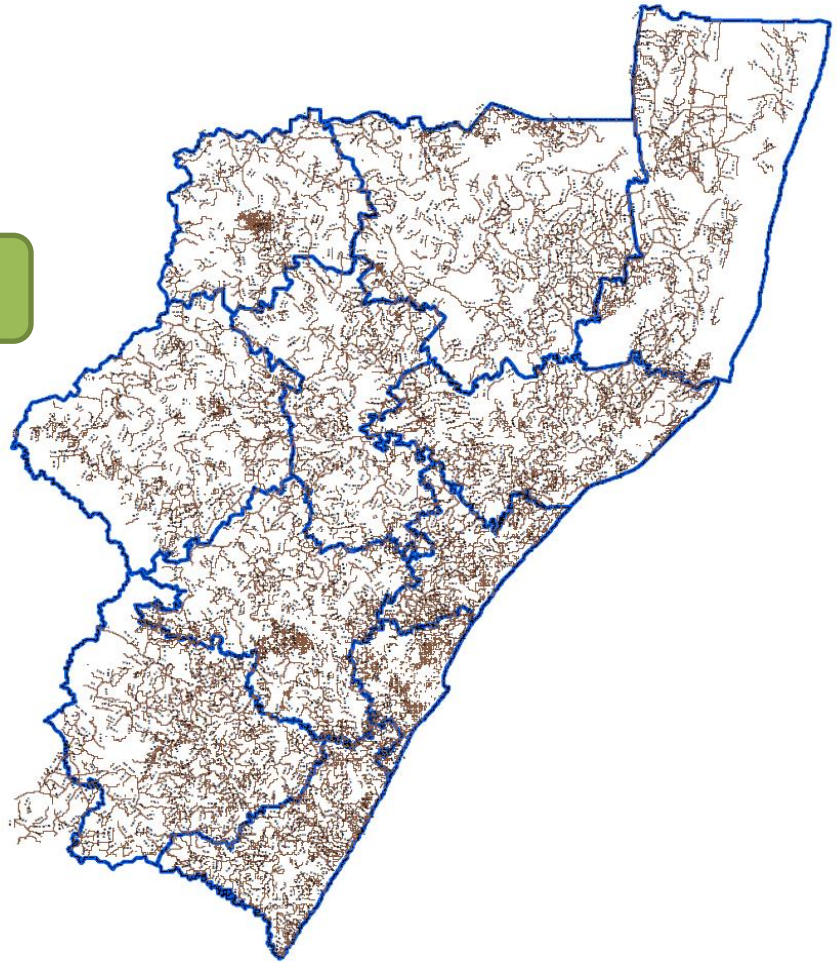
Kwazulu-Natal province

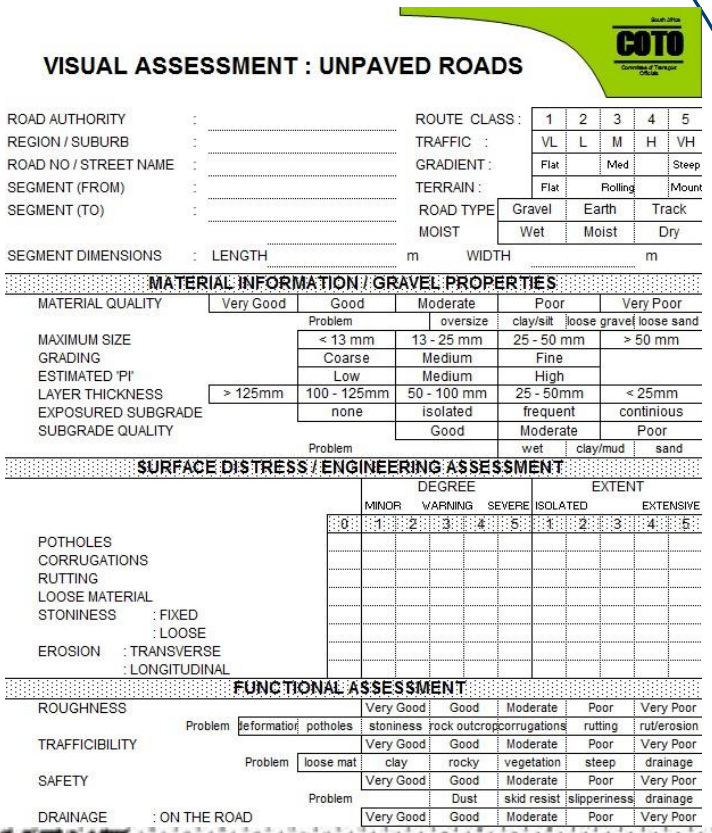
	Functional Class	Length (km)
Paved	Main Roads	7 090
	District Roads	598
	Local Roads	61
	Total Paved	7 749
Unpaved	Main Roads	6 075
	District Roads	11 065
	Local Roads	6 278
	Total Unpaved	23 418
Total KZN Provincial Network		31 167

75%



Estimation of ride quality

Rating	Descriptor	Comfortable, Safe Speed
1	Very Good	> 100km/h
2	Good	80 - 100km/h
3	Average	60 - 80km/h
4	Poor	40 - 60km/h
5	Very Poor	< 40km/h



VISUAL ASSESSMENT : UNPAVED ROADS

COTO

ROAD AUTHORITY :
REGION / SUBURB :
ROAD NO / STREET NAME :
SEGMENT (FROM) :
SEGMENT (TO) :
SEGMENT DIMENSIONS : LENGTH ..... m WIDTH ..... m

ROUTE CLASS : 1 2 3 4 5
TRAFFIC : VL L M H VH
GRADIENT : Flat Med Steep
TERRAIN : Flat Rolling Mount
ROAD TYPE : Gravel Earth Track
MOIST : Wet Moist Dry

MATERIAL INFORMATION / GRAVEL PROPERTIES

MATERIAL QUALITY	Very Good	Good	Moderate	Poor	Very Poor
Problem			oversize	clay/silt	loose gravel / loose sand
MAXIMUM SIZE		< 13 mm	13 - 25 mm	25 - 50 mm	> 50 mm
GRADING		Coarse	Medium	Fine	
ESTIMATED 'PI'		Low	Medium	High	
LAYER THICKNESS	> 125mm	100 - 125mm	50 - 100 mm	25 - 50mm	< 25mm
EXPOSURED SUBGRADE		none	isolated	frequent	continious
SUBGRADE QUALITY			Good	Moderate	Poor
Problem				wet / clay/mud	sand

SURFACE DISTRESS / ENGINEERING ASSESSMENT

	DEGREE: MINOR	WARNING	SEVERE	EXTENT: ISOLATED			EXTENSIVE
	0	1	2	3	4	5	1	2	3	4	5
POTHOLES											
CORRUGATIONS											
RUTTING											
LOOSE MATERIAL											
STONINESS : FIXED											
: LOOSE											
EROSION : TRANSVERSE											
: LONGITUDINAL											

FUNCTIONAL ASSESSMENT

ROUGHNESS			Very Good	Good	Moderate	Poor	Very Poor
Problem	deformation	potholes	stoniness	rock outcrop	corrugations	rutting	rut/erosion
TRAFFICIBILITY			Very Good	Good	Moderate	Poor	Very Poor
Problem	loose mat		clay	rocky	vegetation	steep	drainage
SAFETY			Very Good	Good	Moderate	Poor	Very Poor
Problem				Dust	skid resist	slipperiness	drainage
DRAINAGE : ON THE ROAD			Very Good	Good	Moderate	Poor	Very Poor

FUNCTIONAL ASSESSMENT

ROUGHNESS			Very Good	Good	Moderate	Poor	Very Poor
Problem	deformation	potholes	stoniness	rock outcrop	corrugations	rutting	rut/erosion

Roughness

"The deviation of a surface from a true planar surface with characteristic dimensions that affect vehicle dynamics and ride quality" (*ASTM E867*)

Comparison – IRI versus visual

Nigeria

Use of satellite images for pavement evaluation

Transport Infrastructure Monitoring Project Phase II:

Funded by: Catapult Satellite Applications

Consultants:

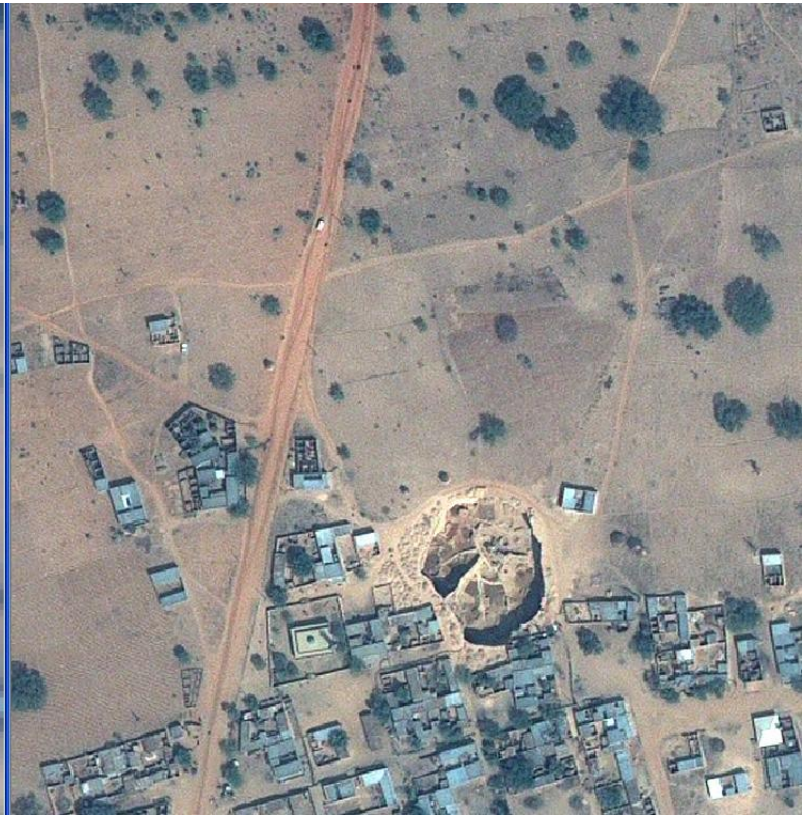
- TRL Ltd
- Airbus Defence and Space

Cooperation with the Nigeria Infrastructure Advisory Facility – funded by DFID/UK

Pilot area – Kano State

Data actually used in project

SPOT6 satellite image 1.5m resolution for road mapping



Pleiades satellite image 0.5m resolution for road condition

Condition assessment system

0P – Paved, good to fair condition

0E – Earth, good to fair condition

1E – Earth, fair condition

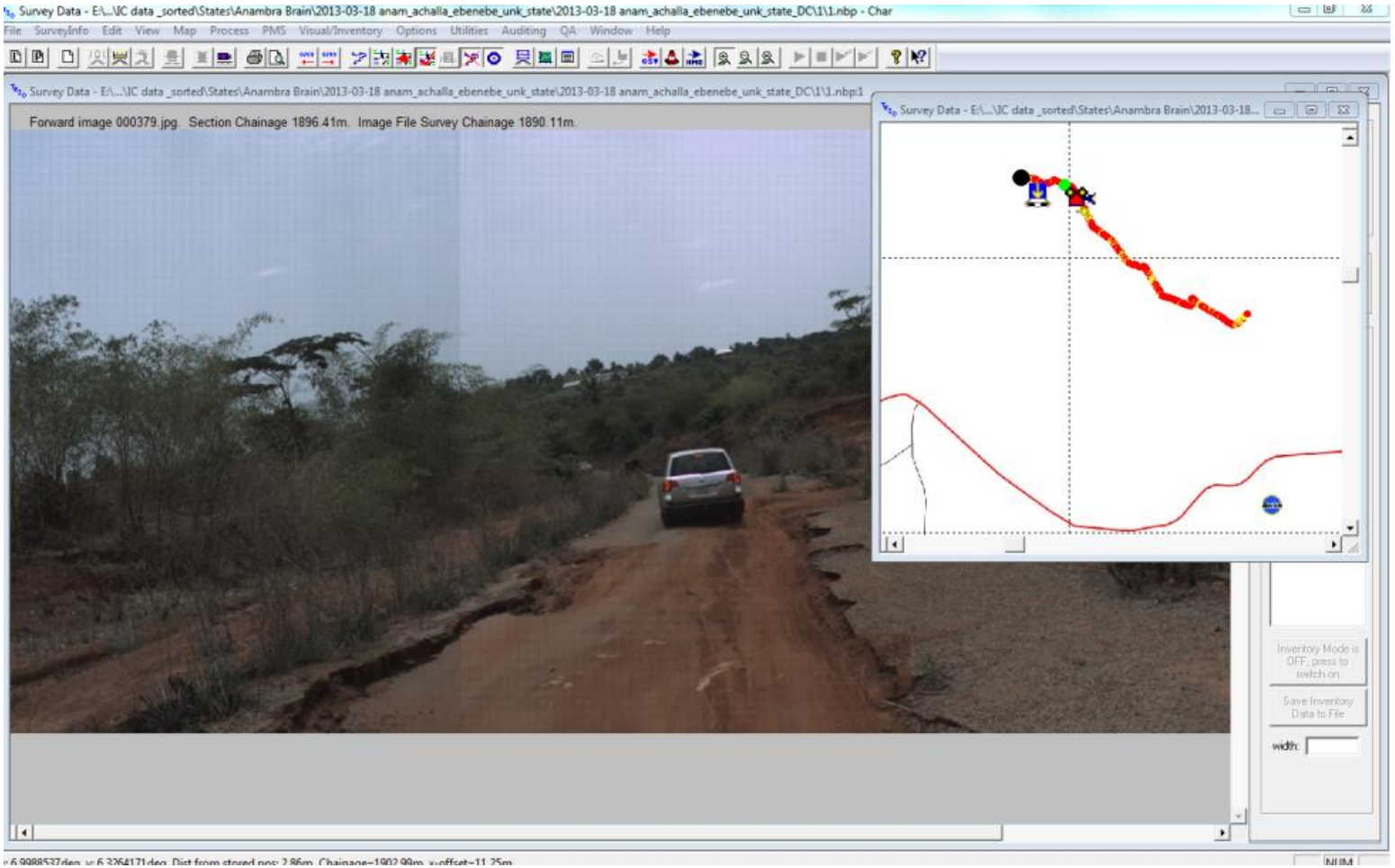
2E – Earth, fair to poor condition

3E – Earth, poor condition

4E – Earth, very poor condition

Ground truthing using image collector

Forward facing images



Condition assessment rules

0P

0E

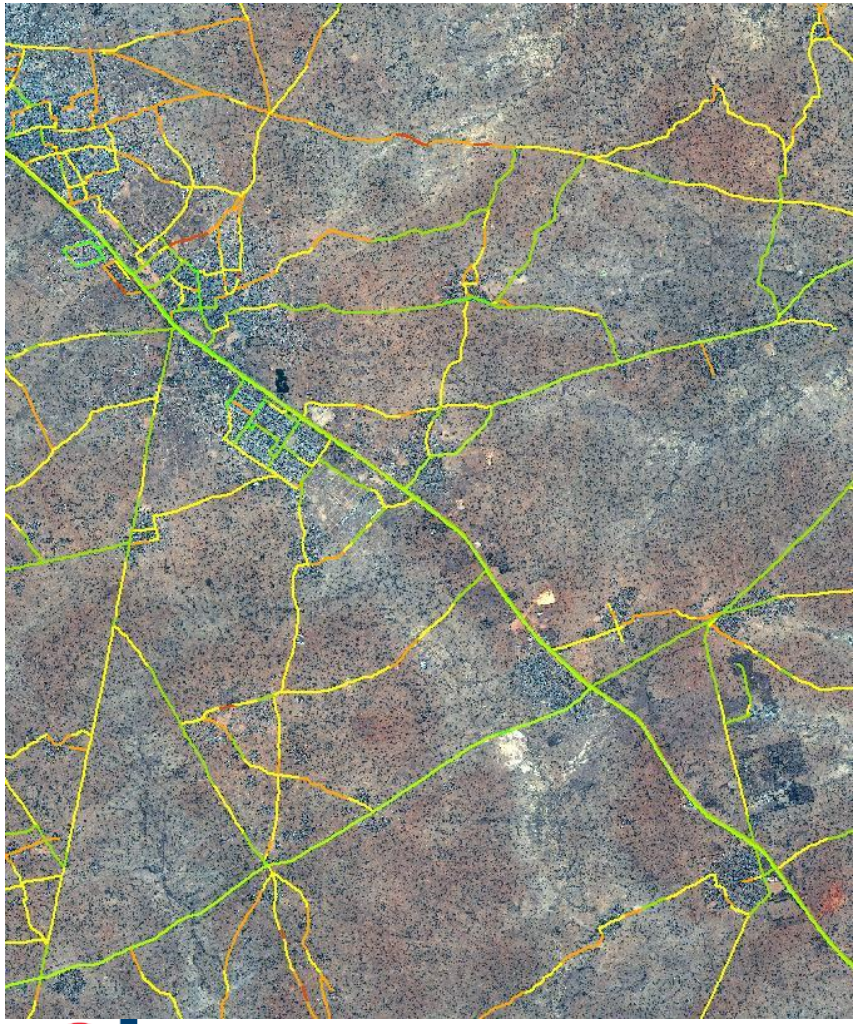
1E

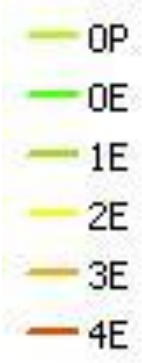
2E

3E

4E

Results of assessment





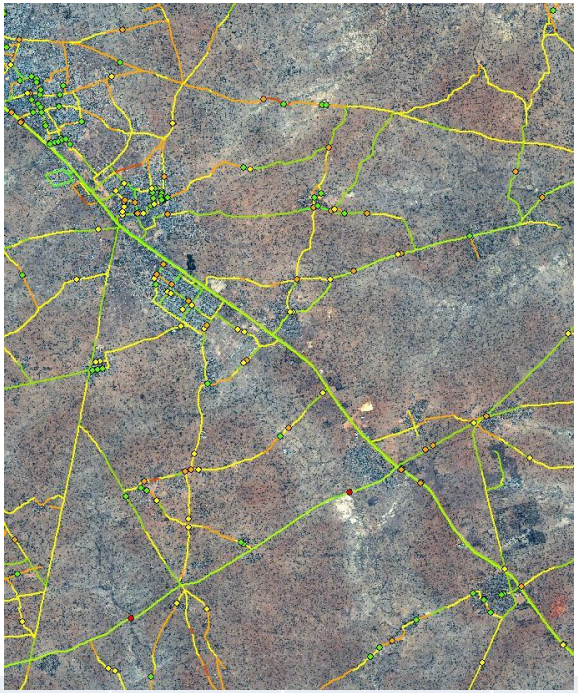
- Road condition assessment based on rules
- 50cm resolution Pleiades satellite imagery

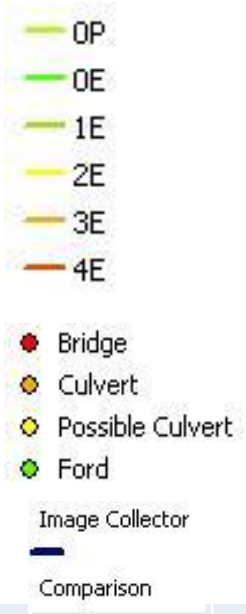
Change of condition

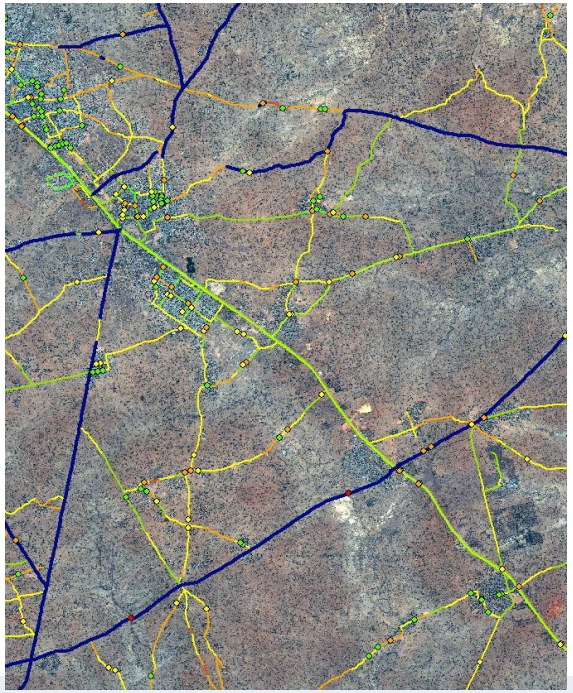
Bridge identification

Culvert identification

Condition assessment accuracy

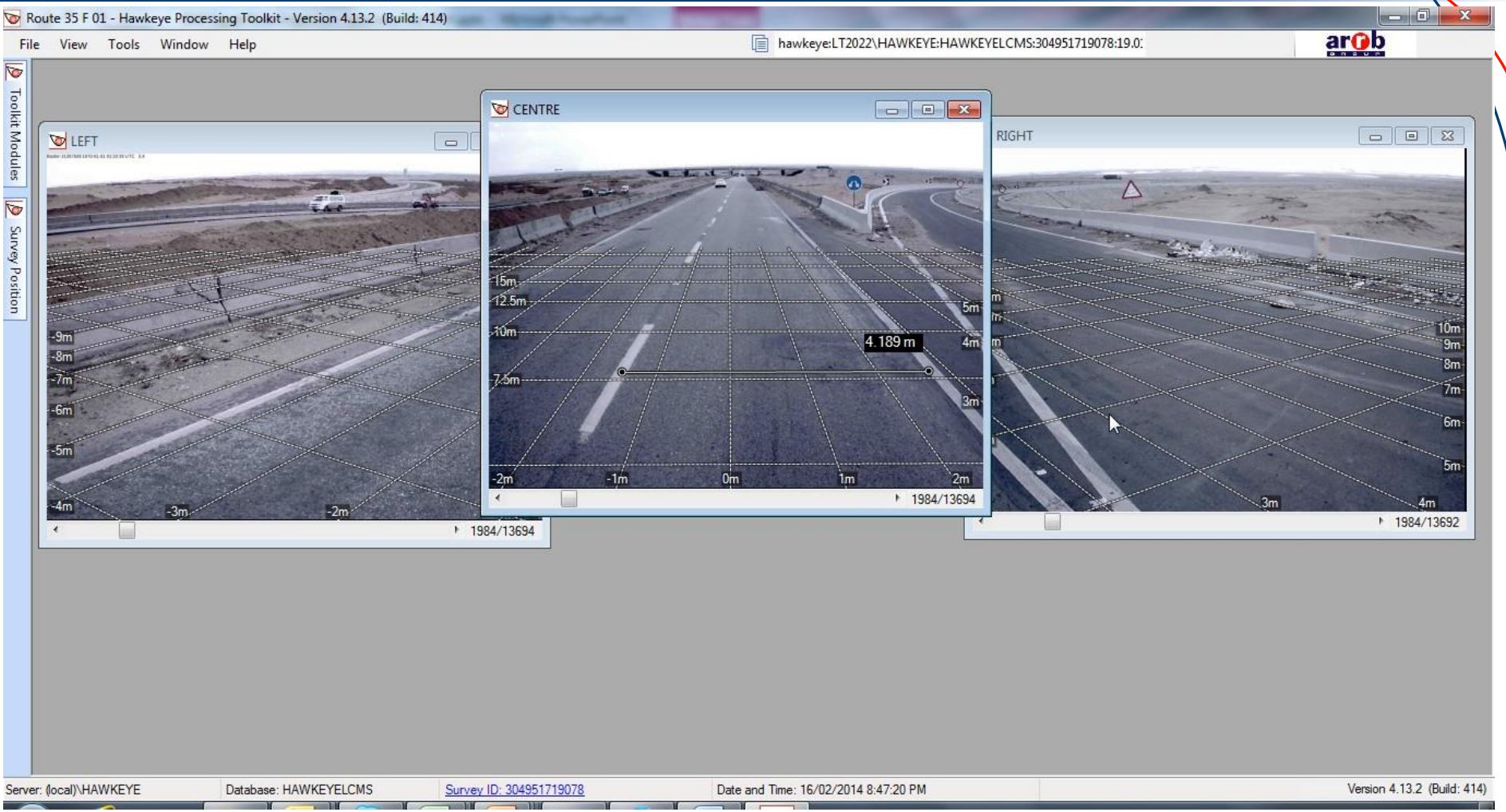




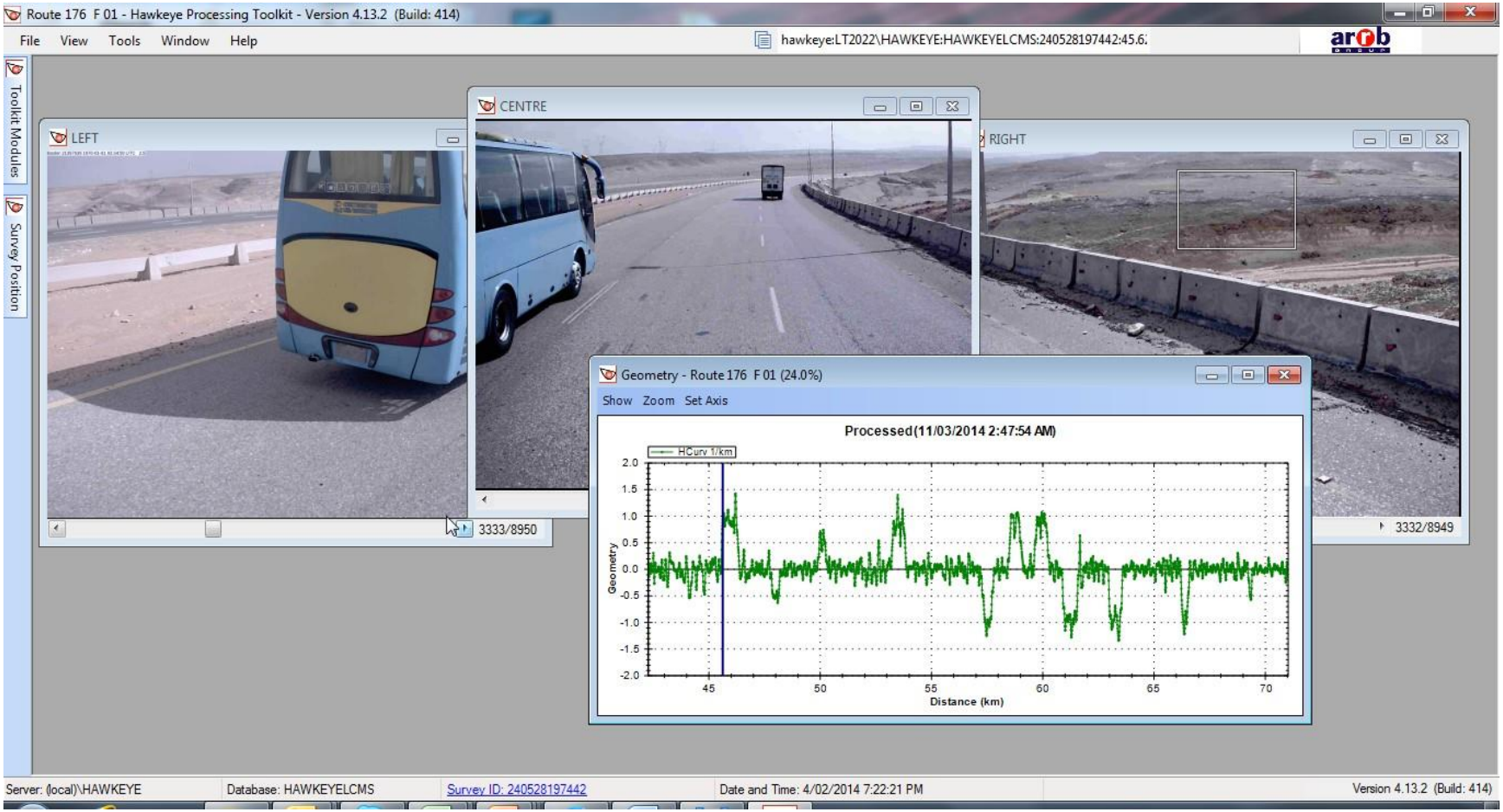


Condition	Length (km)	Positive Correlation with Image Collector	Negative Correlation with Image Collector	% Correlation	Comments
0P	1.9	1.9	0	100	Excellent correlation
0E	1.7	0.2	1.5	12	Condition for only one road - 0E looks like 0P on imagery
1E	8.5	6.7	1.8	79	Very good correlation
2E	19.4	11.5	7.9	59	Good correlation - tendency to condition as 3E
All	31.5	20.3	11.2	64	Good correlation for all scenarios

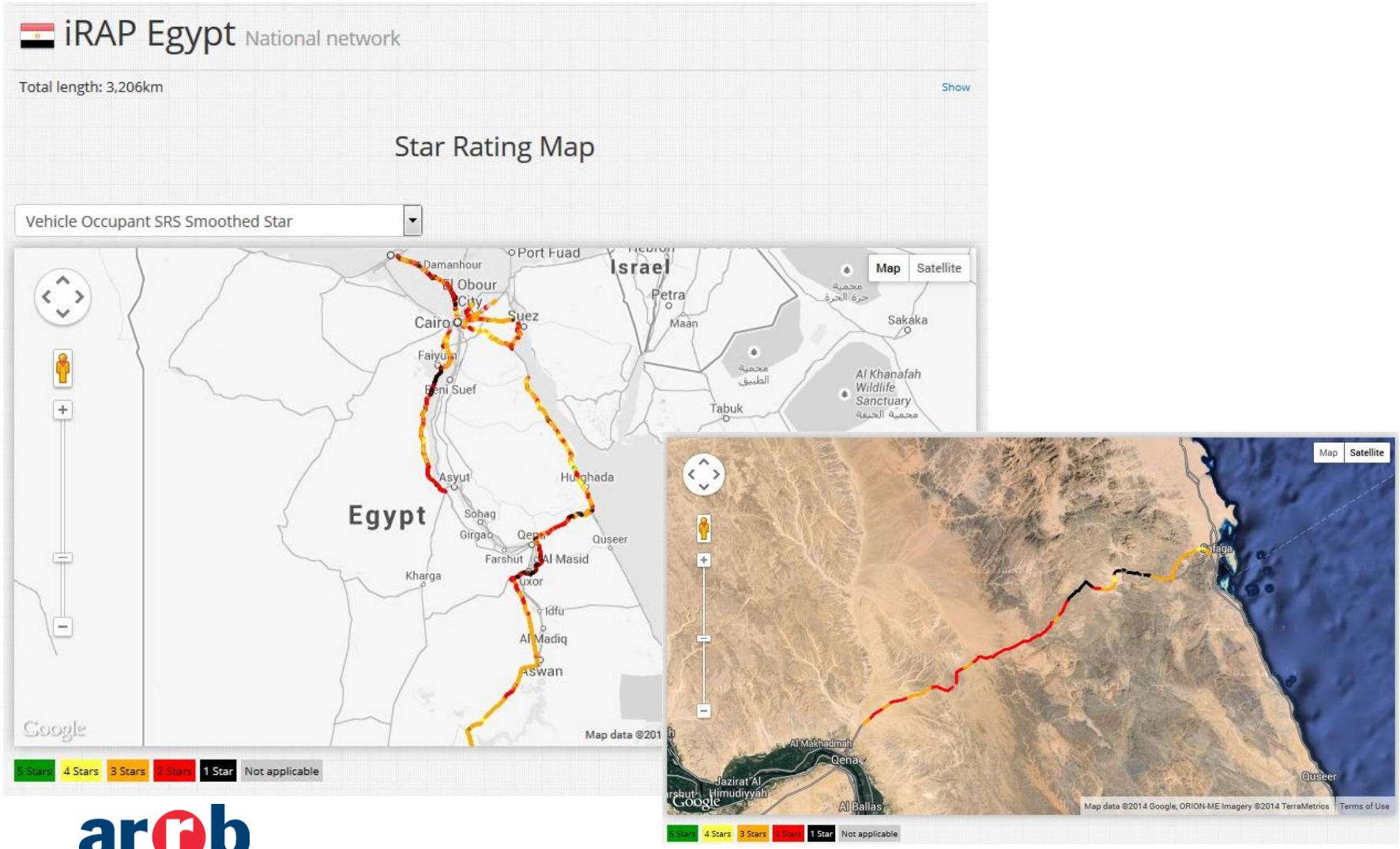
Egypt – road safety



Horizontal curvature

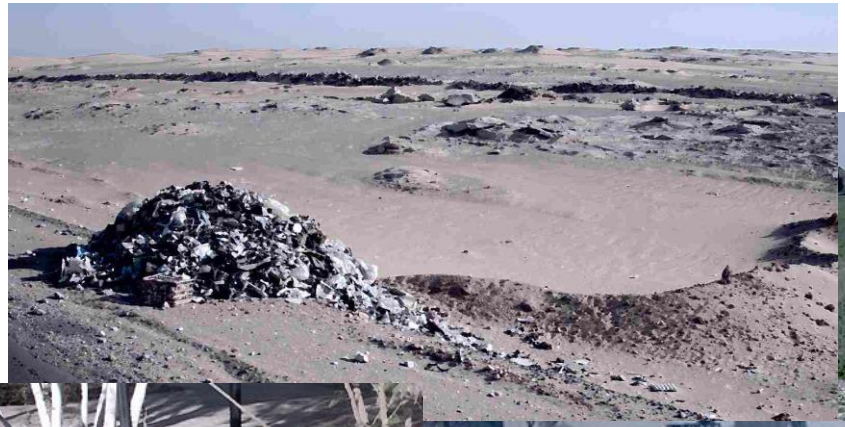


Star Maps (preliminary results)



Caught on film

Caught on film



Drive by shopping

Road assessment programs

EuroRAP
EUROPEAN ROAD ASSESSMENT PROGRAMME

iRAP
INTERNATIONAL ROAD ASSESSMENT PROGRAMME

AusRAP
Australian Road Assessment Program

usRAP
UNITED STATES ROAD ASSESSMENT PROGRAM

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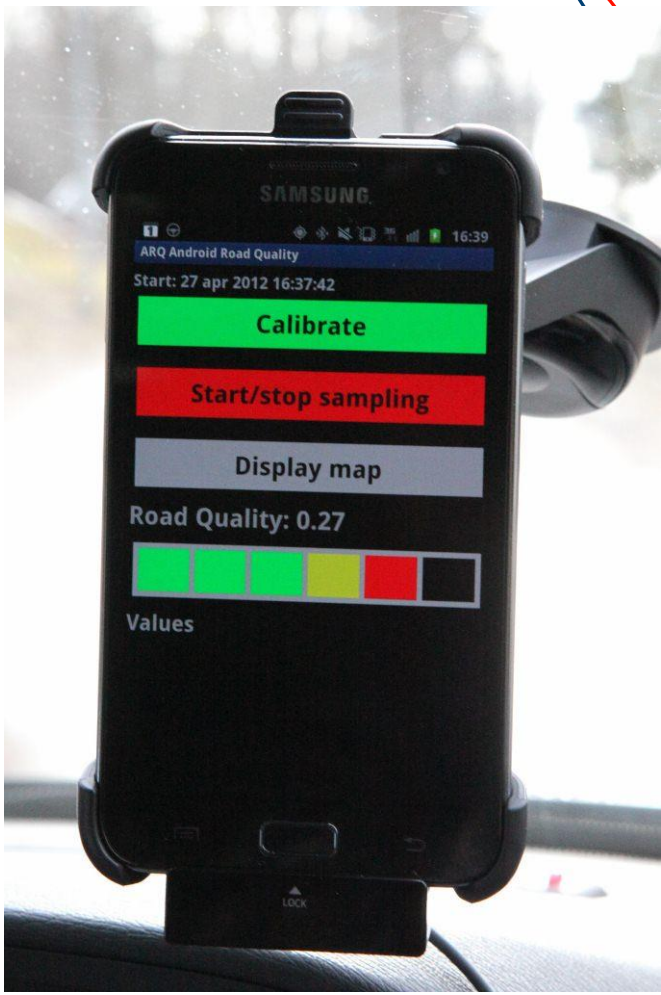
A small island nation

Kiribati

- Remote Pacific Island nation
- Low population
- Small road network

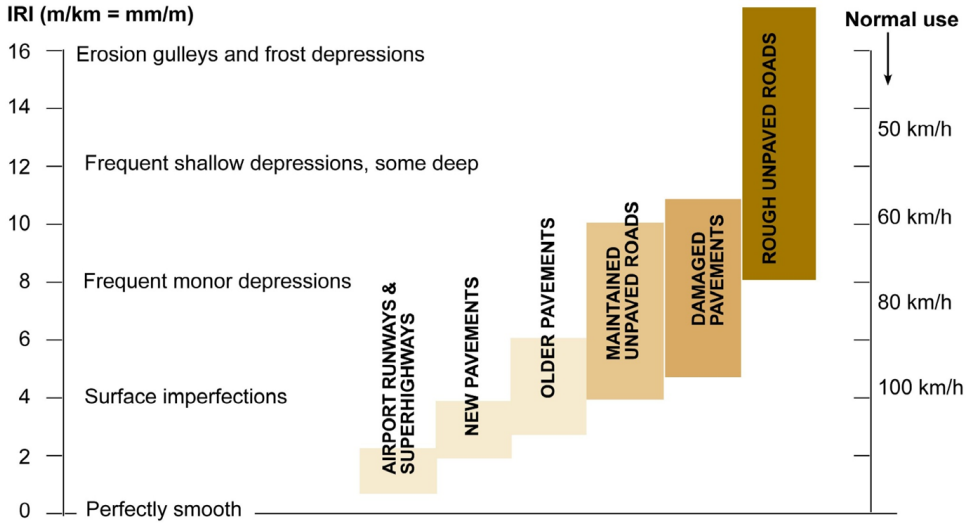


Europe

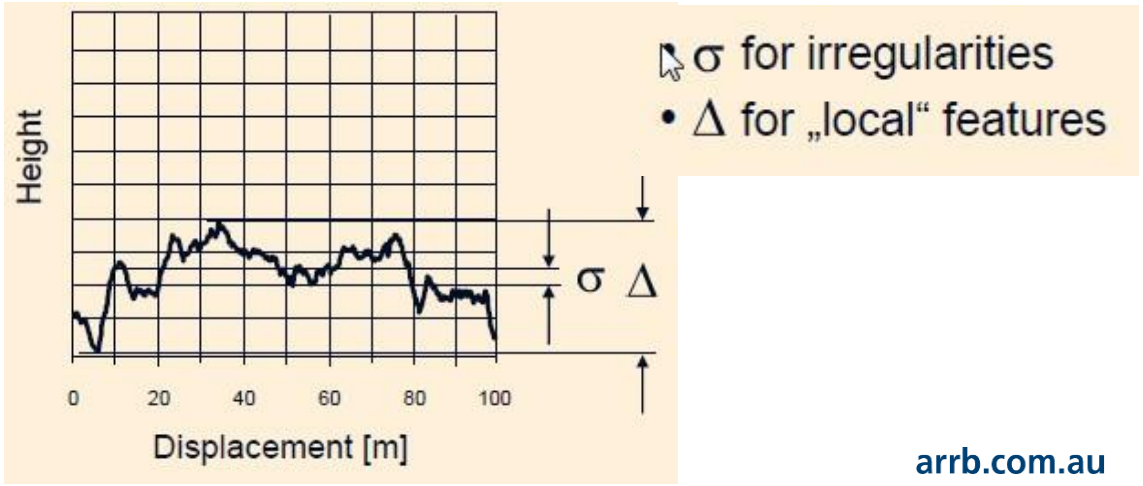
- TRIMM (Tomorrow's Road Infrastructure Monitoring & Management) advanced & specialised monitoring techniques, structural and surface condition
- ROSANNE main objective is the harmonisation and standardisation of the measurement of skid resistance, noise emission and rolling resistance of road pavements (predecessors were TYROSAFE, HERMES , SILVIA and MIRIAM)

Roughness statistics

- IRI



- WLP (weighted longitudinal profile)



Traffic speed condition surveys (TRACS)

- These largely cover the condition of the pavement surface
- TRACS surveys have been carried out on the English Strategic Road Network since 2000 (around 15,000km of main line lanes)
- The surveys are carried out by an independent contractor using a survey vehicle specifically constructed for the purpose
- TRACS surveys are subject to a detailed quality assurance regime, currently carried out by TRL Ltd

Traffic speed condition surveys

TRACS 1&2

- Detailed “end result” specification was issued in 1999 for the measurement of:
  - location
  - surface condition including surface cracking and rutting
  - road geometry

TRACS 3 from 2012 to present

The TRACS survey provides the following measures of the condition of the pavement surface over the main line of the HA's strategic road network:

- Rut depth
- Ride quality
- Texture depth
- Cracking
- Surface Deterioration
- Fretting
- Lane fretting
- Surface type
- Noise
- Geometry
- Downward facing images
- Forward facing images
- Retro-reflectivity

Traffic speed structural surveys

TRASS1

- Network surveys using TSD already undertaken in TRASS1
- Two survey contracts let for a Winter survey and a Summer survey
  - Yotta (winter)
  - WDM (summer)
- Reports are available

Winter coverage

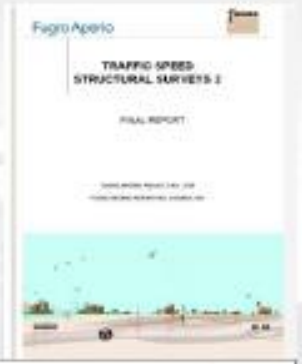
Summer coverage

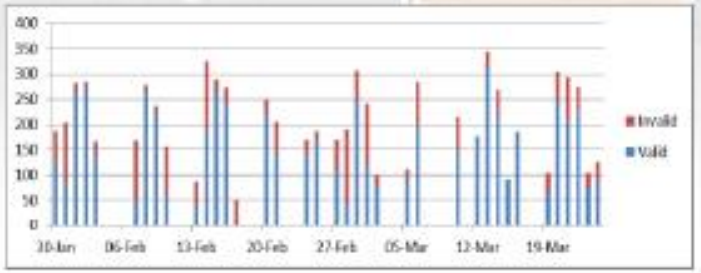
Survey period	Total surveyed [km]	Total valid [km]	% valid
Summer (WDM)	7057	6211	87.6%
Winter (Yotta)	7838	5775	73.7%
TOTAL	14895	11986	80.5%

Traffic speed structural surveys

TRASS2

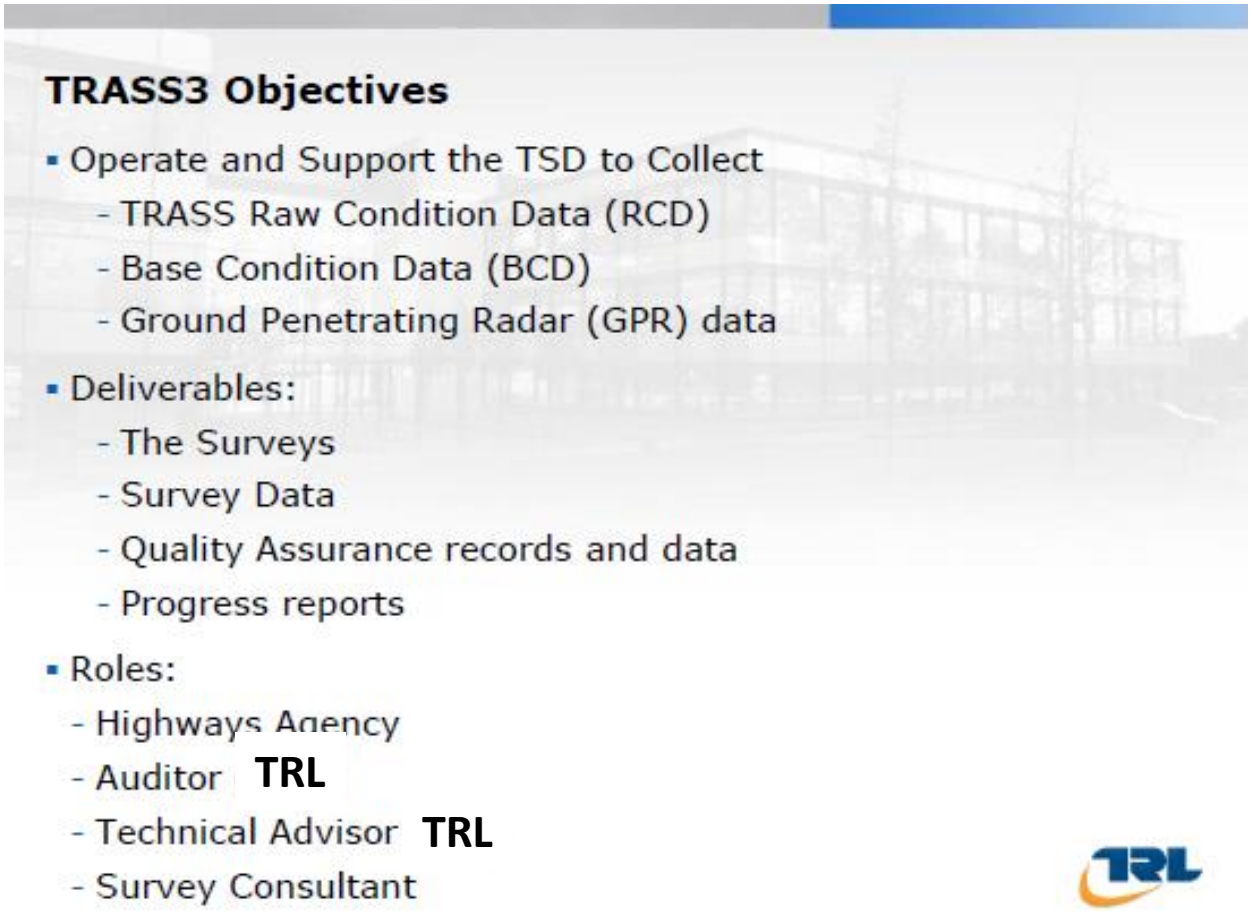
- Network surveys with TSD undertaken by Fugro
- Survey Jan 2012 to End Mar 2012
- Data validity
  - Feb surveys: 67%
  - March surveys: 78%
  - Average: 75%
- Report is available





Traffic speed structural surveys (TRASS3)

- 3 year + 1 + 1 contract
- Started September 2014



Australia

Common automated pavement condition parameters (meat & 3 veg)

- roughness
- rutting
- texture
- skid resistance
- strength

Moving to more sophisticated measures

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Pavement strength testing

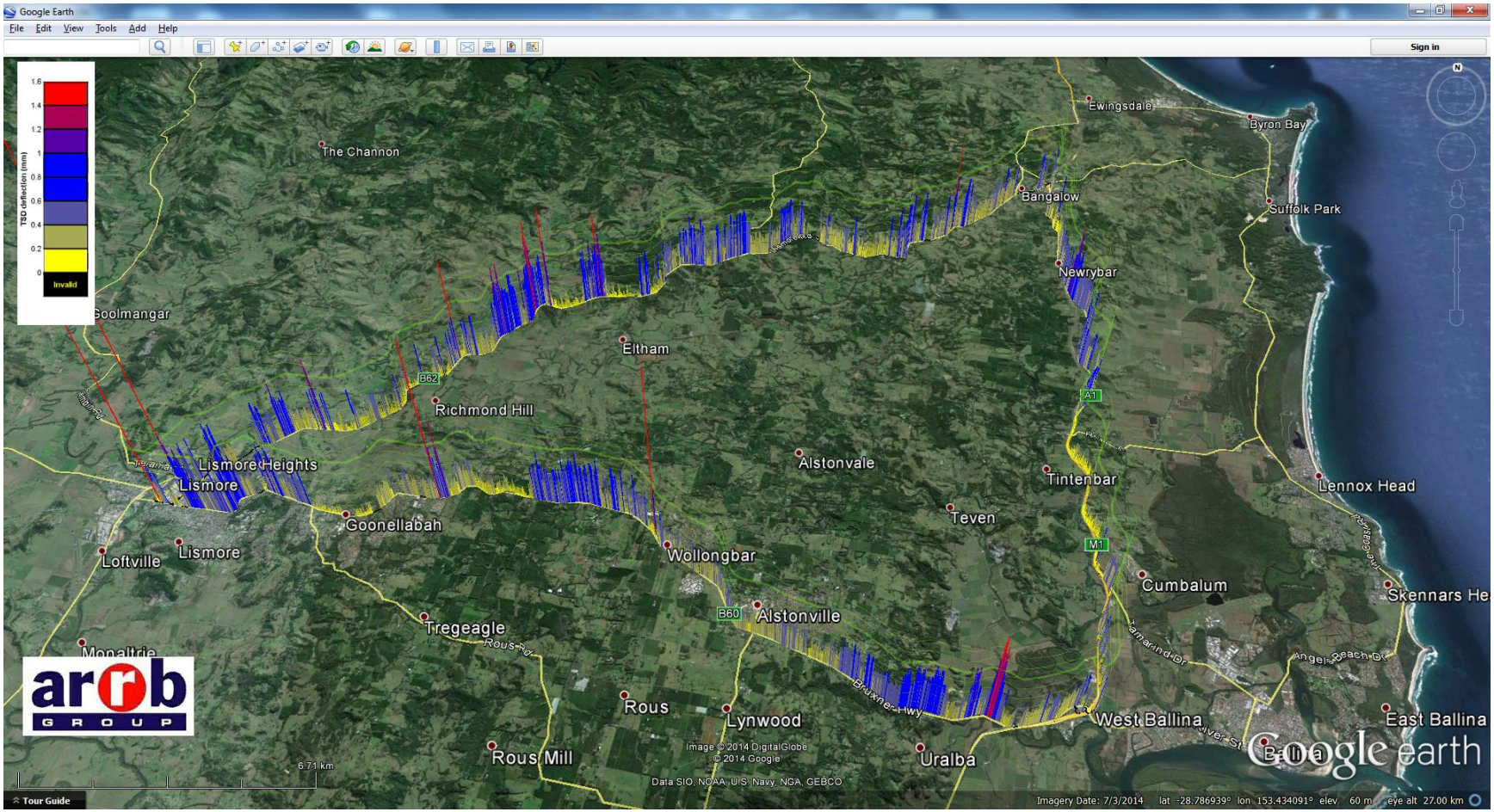
- Traditional methods such as FWD still in wide use
- Relatively slow technology
- Not safe for network testing; requires significant traffic control

2010 TSD trial

- 18,000 km in two states

Purchased a TSD

Benchmarking



Source: Google Earth, “map title, scale” map data: CNES/Astrium, Sinclair Knight Merz & Fugro, Google, USA.

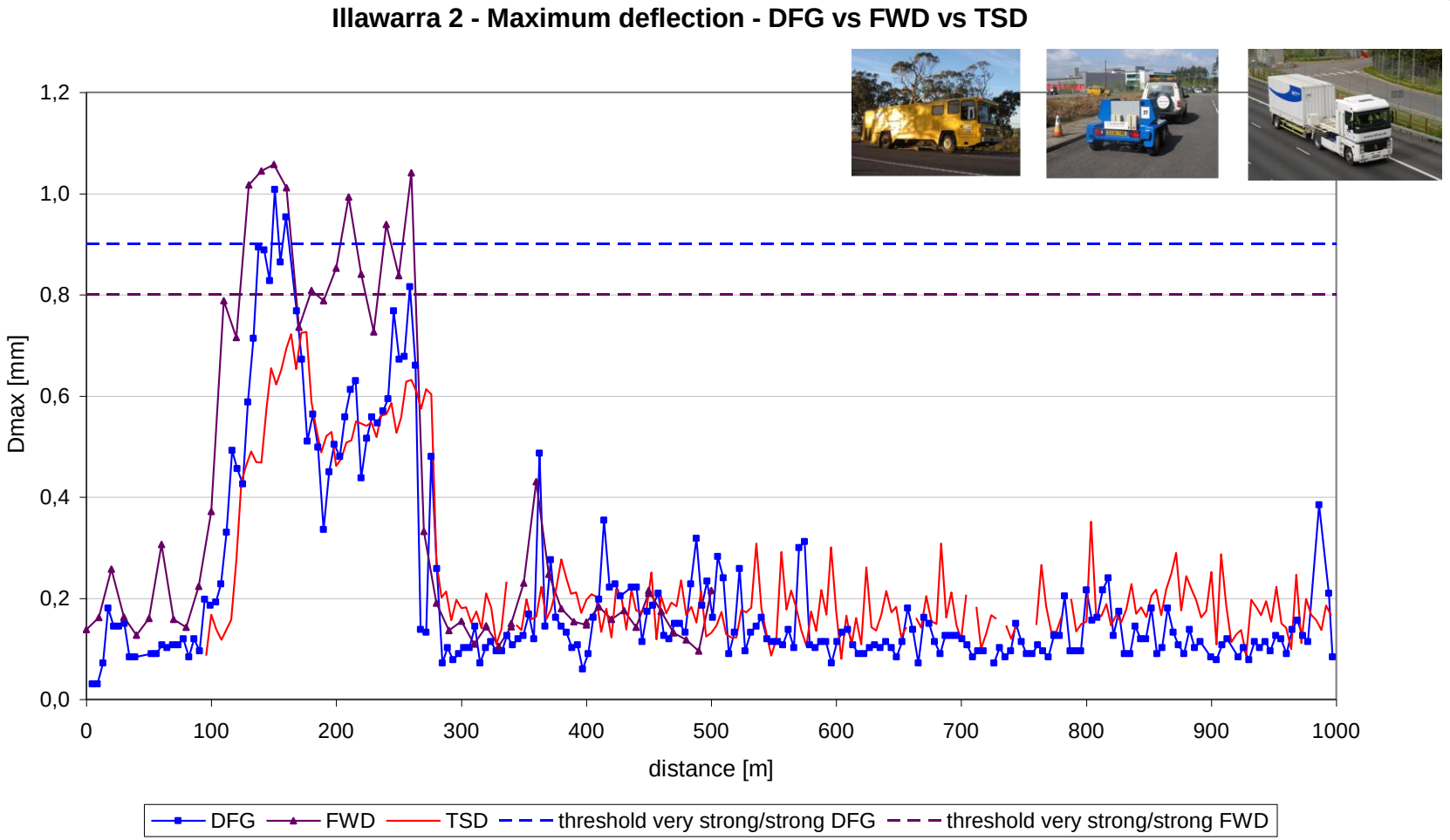
Even made the news.....

https://au.prime7.yahoo.com/a1/news/a/-/national/24755669/what-lies-beneath-video/

Not the only one

TSD #	Country	Year	Organisation
1	Denmark	2004	The Danish Road Directorate
2	United Kingdom	2005	Highways Agency (TRL)
3	Italy	2010	ANAS S.p.A.
4	Poland	2011	IBDiM
5	South Africa	2012	SANRAL
6	China	2013	RIOH
7	USA	2013	Greenwood
8	Australia	2014	ARRB

Comparative measures



More than just deflection

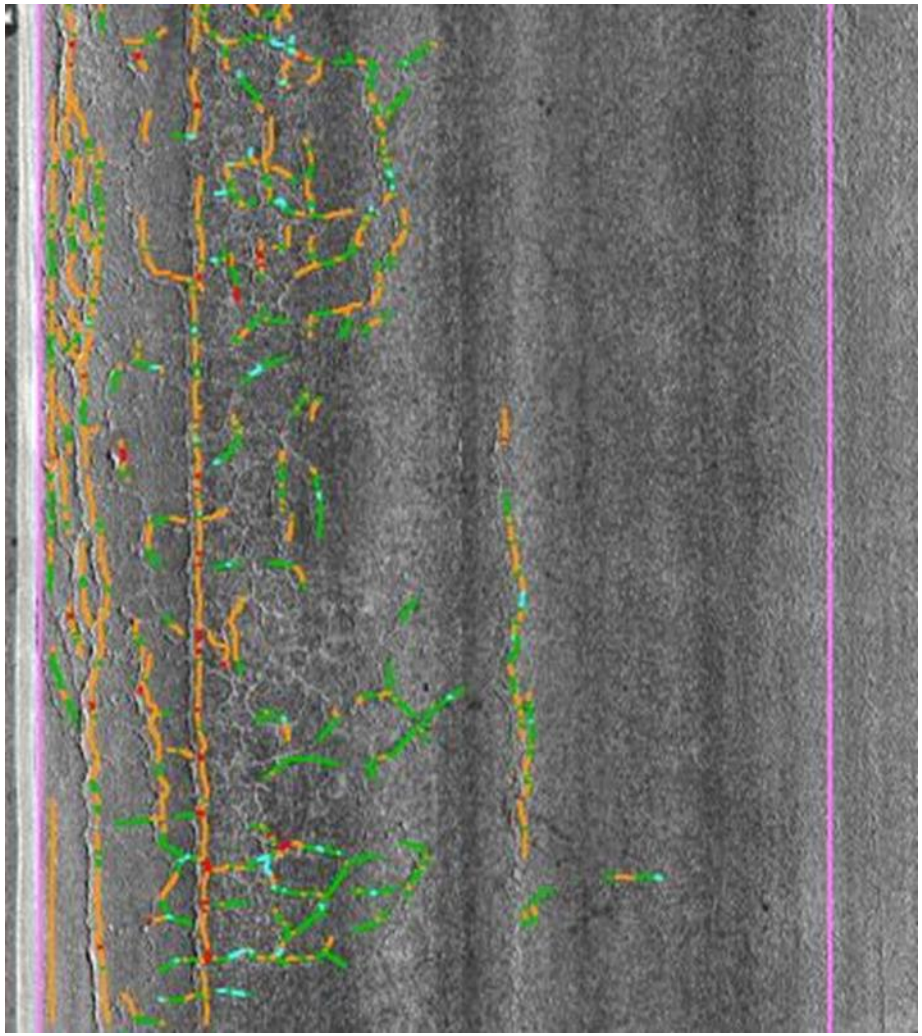
- Roughness
- Rutting
- Texture
- Cracking
- Imaging

Big burger approach

- Cost benefits to road agencies
- Reduction in number of surveys
- Safer data collection methods
- More data

New technologies

- Original test methods developed in 2003
- *'Since then, new road condition monitoring technologies….. have been developed'*
- *'The existing suite of Austroads documents do not provide specifications or test methods for these new technologies'*



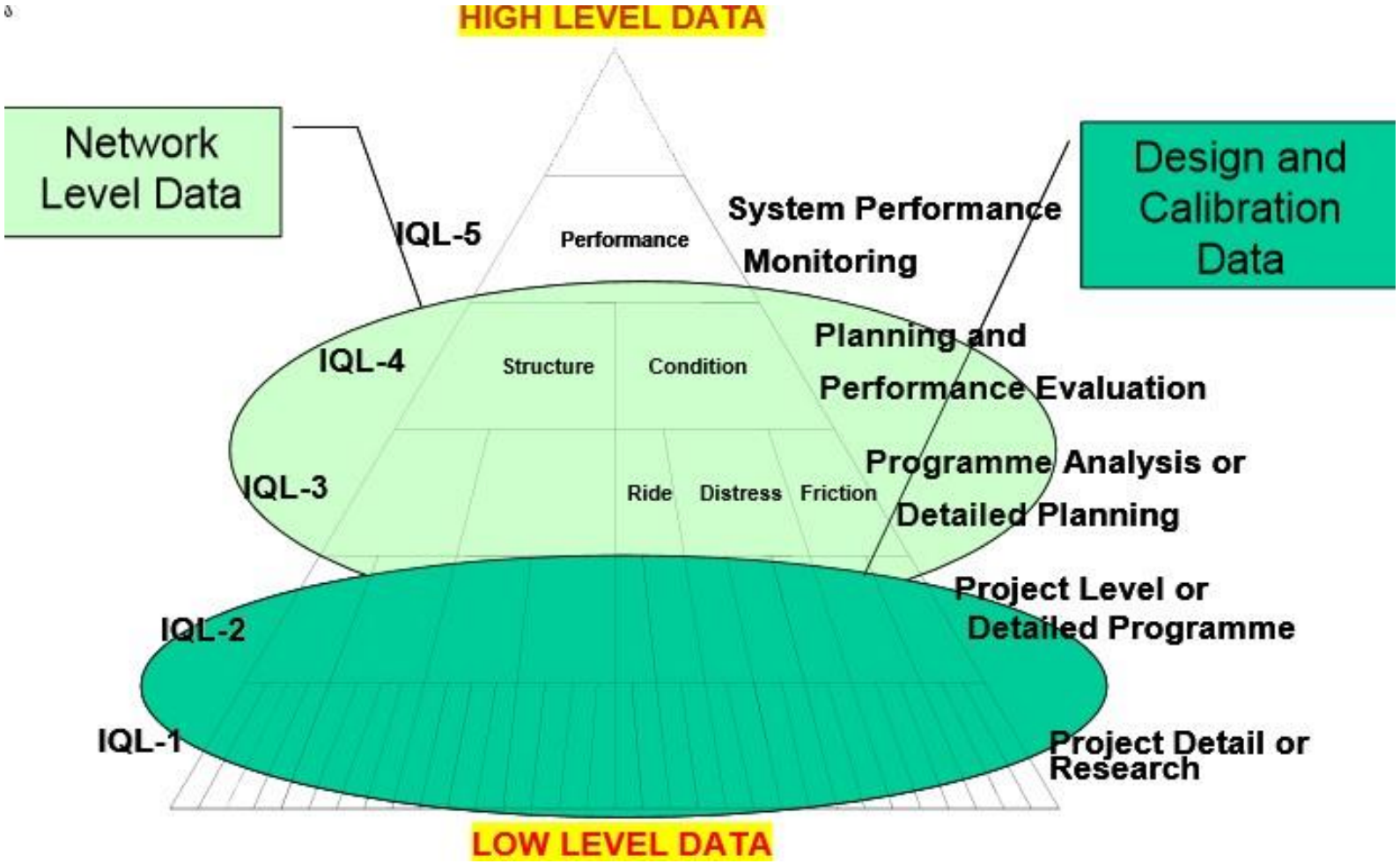
New Zealand (*Aotearoa*)

- Friction testing of entire road network
- *'it is recommended that authorities in New Zealand should give strong consideration of using the automated crack detection'*
- *'the reality is …. that in the new performance based world of today, the repeatability and robustness of visual surveys are simply not good enough'*

A pyramid

Bennett & Paterson

Another pyramid



Bennett & Paterson

Pavements – a valuable asset

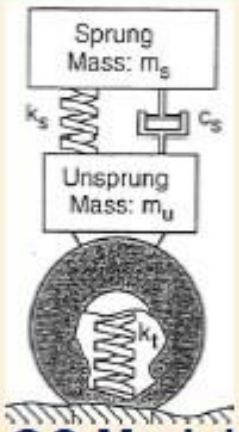
Are we getting it right?

Right measures? Right quality? Right analysis? Right quantity? What is the benefit?

Kitami City, Japan (fit for purpose)

Passenger/Commercial Vehicle (Road Patrol Car)

Suspension System



QC Model (for IRI)

arrb GROUP

Thank you

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RPUG
Road Profile Users' Group