Volume

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TRACKS4AFRICA

Overland Navigation

The Navigation Story

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Unit 8, Innovation Center 1, Meson Street, Technopark
Stellenbosch, 7600, SOUTH AFRICA
Phone +27 (0)87 808 6170 • www.tracks4africa.com

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Where is North?

The mental map. Where is North?

Unlike so many animal species such as the honeybee, the newborn leather back turtle finding its way to the water, the migration of birds over huge distances, the Salmon dynamics in the rivers of North America and migrating whales; the human species (both ancient and modern man) possesses no built-in ability to navigate.

To know where you are and to navigate from A to B requires some or other form of intellectual effort to construct or to maintain a 'mental map' of where you are in relation with your surroundings.

The human 'mental map' at best is only a 'relative map'. It exists relative to known landmarks. Absolute directions (North, South, East and West) play little or no part in the human 'mental map' and why complicate the mental map of your kitchen or the office with absolute directions?

Standing at the George post office my wife, Hester, can accurately show you the direction to the shopping centre, the best hairdresser in town, the police station, the bank and her favourite coffee shop. But asking her where North is and it's a different story.

My own little game for many years at the campsites in remote destinations of Africa is to ask fellow campers, where the camp offices and ablution blocks are. For these you get accurate directions. But when asking: "Can you show the direction of where North is?", you get a different answer from every person.

A good mental map must include absolute orientation. It must know (more or less) where North is. This is essential when travelling to new and unfamiliar places.

A mental map can only be in one of three modes. It can be screwed up from the onset, it could be temporarily intact or it is about to become screwed up. To keep the 'mental map' intact to a degree that you (and your travel companions) are at ease with, requires an array of external navigational aids to constantly adjust itself.

Such as deciding which is the 'most' beaten track, road signs, known landmarks (hopefully you will find them at expected locations) the position of the sun relative to the time of day and asking directions from the local people.

Occasionally you may refer to a map to confirm location, distance, time and absolute directions. These maps come in various formats and are of varying quality. Formats – Raster (printed paper map, satellite image) and Vector (lines and points typically found on the GPS). Quality – from the 'not to scale' directions from the B&B's web site to very accurate topographical maps. ***In GPS terms however the only accurate maps are the ones derived from actual GPS recorded data.***

The ability to maintain and to adjust a mental map to some degree of integrity can be called 'navigational skills'. To navigate one need to first of all know where you are and then know where you want to go. Getting there in a way that is energy efficient (hikers) or environmentally responsible (bundu bashing towards a waypoint you got from a paper map) is yet another discussion.

There is not a human soul on planet earth that has mastered this skill of navigating without an external aid. The mental map alone is either already screwed up or about to become screwed up. When this happens, you are simply lost.

Being tired and taking a nap whilst spouse takes over the driving, only to wake up with your mental map a nice 180 degree out of phase.

"Stop the car girl, you're driving in the wrong direction. You're driving east instead of west". "Nope" she will reply. "Check the GPS, check the map, see the sun, it is 17h00 and we driving head on into the direction of the setting sun". Nope he will say "The GPS is wrong, the map is wrong, the compass is wrong and the sun is wrong. Stop the car, make a U-turn and drive back, you're driving in the wrong direction".

When lost, you start questioning the integrity of navigational aids and it is not entirely incorrect to do so. For the overland traveller there exist a plethora of navigational aids available in both paper and GPS format. This is a lucrative market and every Tom, Dick and Harry seems to have a map on the market, all of varying quality. And rightly so, there are no Navigational Standards to adhere to in this domain.

The road maps of Africa are bad and the GPS maps constructed from similar bad maps. In the cities where it makes commercial sense, one could expect a reputable mapmaker to have streets mapped by means of actual GPS recordings, however outside the cities and off the main road it's a different story all together. Maps (GPS and paper based) are created from official Surveyor General's maps which are 40 years old, or lines manually traced from satellite imagery which is poorly ortho-rectified, by technicians who cannot tell the difference between cut-lines, power lines, pipe-lines, railway lines or road lines.

In some cases you have the individual map publisher that creates the impression that map data is carefully researched and compiled. The map has latitude and longitude grids references that creates the familiarity of a topographical map, however if one reads the instructions on these very maps it warns you not to lift co-ordinates from the map, that some tracks are hand drawn because no relevant satellite images are available and so on. Confessions such as these one would not find in the marketing material and alas these maps should be treated as informative only and not suited to navigation.

When lost, you begin making decisions that can have serious and catastrophic consequences for both environment and travel safety.

In May 2003 and on day 15 the Snell couple was found in Damaraland (Namibia). Herr Snell died the previous day. They got lost and their vehicle ran out of fuel. The consequences of inaccurate navigational aids or the inability of using them could have dire consequences.

Stopping next to a car of a fellow tourist somewhere in Moremi (Botswana) asking the question "Where is North?" It is midday (the sun directly above) and after lots of game driving on the maize of Moremi tracks with the only landmarks water crossings and more water crossings and trees and more trees no-one can accurately point to North.

It explains why Moremi is possibly the worst-case scenario for vehicle track pollution.

The same is true for the plains of the Massai Mara (Kenya), Liuwa Plains (Zambia), Damaraland and Kaokoland (Namibia)

As far as navigational aids are concerned, the GPS and satellite image has forever changed the way we navigate. To what degree remains to be seen.

Consider a super accurate GPS street map uploaded in a GPS with auto-routing anyone can navigate the streets of downtown Johannesburg. Moreover, you can do this flawlessly and better than a taxi-driver who has done this for many years. But man, if that GPS breaks half way to your destination you are terribly lost. Why? Because I bet you were not paying attention to anything other than “Sally’s” voice telling you to turn left or right.

In the city you could always ask a local for directions or in worst case scenario call a taxi to drive in front of you to your destination (it has happened!).

In the remote parts of Africa these luxuries however are not available. ***Where you could find very accurate GPS maps for your travels in Africa, the responsible traveller will still have auxiliary navigational aids such as paper***

maps and compass. These are to be consulted from time to time to ensure that the mental map stays intact even after the GPS's batteries have run flat.

So what then is Eco-travel? It's Navigation in remote and eco-sensitive areas. It could include going nowhere slowly, as long as it does not get you lost to the point that you start damaging the environment or putting you and your travel companions in danger.

What is a GPS and what is a MAP?

Modern GPS receivers offer many functionalities (some can even tell best times for hunting and fishing), but all this clouds the answer to the question of "what is the basic function of a GPS?"

When a GPS unit downloads data from satellites it does so to fulfil one primary objective, to establish and to report position. It is reliant on the "Global Positioning System" from which it receives its data that allows it to calculate its position on Earth within accuracy of 15m. This accuracy depends on many factors, however in the open desert one could expect a recent model GPS to be as accurate as less than 5m. There are methods of using GPS to derive even more accurate position, however this falls outside the scope of this document – ask your local land surveyor for an explanation.

Your GPS unit must inform you of your position accurately and it does so by providing your current location's longitude and latitude. This function, by itself, cannot show you how to reach your destination. The choice of a route to a destination is provided by a MAP (either paper map or GPS map).

In the case of a GPS fitted with a base map, the GPS will plot your current location on the base map. The accuracy of the derived information is now also dependant on the accuracy of the base map.

Paper maps are available with many appealing features, e.g. satellite imagery as background, telephone numbers of lodges, GPS coordinates etc, but all this clouds the answer to the question of "what is the basic function of a MAP?"

A map at best is a map maker's impression of reality. For GPS base maps one cannot stray too far from the reality as your GPS will plot your position within 15m from reality. A paper map on the other hand could allow some artistic freedom. On a 1:50 000 paper map 1mm equals 50m in reality. People relying only on paper maps should know that one would need to take this into account and features such as mountains or dams on a paper map are all relative. The map maker has a responsibility to ensure that the impression created would

allow map savvy users to derive their approximate location within reasonable accuracy.

However, more recently the introduction of GPS coordinates on paper maps has blurred this responsibility. An absolute coordinate is given alongside a relative impression of reality. One needs to be very careful and know the origin of the map in order to know how to interpret it.

For GPS base maps it is not acceptable to be an impression of reality. If your GPS is going to apply absolute logic in order to plot your position on the map within 15m, then your map has to be to the same relative accuracy. This brings us to the requirement for GPS maps to be built only from GPS recordings, or simply put, the base map must be as accurate as the GPS position.

The basic function of a map is to provide an impression of reality at an equally accurate scale as your method of deriving your position. ***A map should allow one to determine where you are at present and then determine a route to your desired destination.***

If one were to combine the accuracy of a position derived from a GPS and a reliable map, one ends up with a comprehensive navigational solution. ***Personal Navigation Devices (PND) are GPS combined with a processor and algorithm that allows for route calculation on a build in routable map.***

The two types of electronic maps

There are two types of electronic maps, raster and vector. A vector map comprises only of lines, points and polygons of which their exact position in space is known. A vector map can be edited and easily changed. Vector map clarity or resolution remains clear at any zoom level (independent of map scale) but is artistically limited because the only map making building blocks are lines points and polygons.

- **A Raster map** comprises of pixels of graphics. It is the end result of 'painting' on an electronic canvas. A raster map is bound by its map scale. Take a raster map of 1:250,000 and zoom in to 1:50,000 and the map will be unreadable because map features cannot re-scale as one zoom into a raster map.

- **A Vector map** comprise lines, points and polygons, however the building blocks of all of these features are points. In the case of lines and polygons these points are joined to show line or polygon features.

Navigating to a point

In the absence of a routable base map, one might have to use a GPS to navigate to a point. This is often the case when a single coordinate is taken either directly or derived from a paper map or travel guide.

This is similar to taking a heading with a compass and navigating in a straight line until the next heading is taken.

If the circumstances dictate this sort of navigation then one would not have a choice but to follow your heading. However this holds dire results for nature as one often find yourself not navigating on an existing track in such circumstances. This leads to track pollution and causes unnecessary damage to fauna and flora.

First generation GPS receivers (early 90's) were not 'map capable', i.e. they were unable to load vector maps for viewing on the GPS screen. The market soon offered a new generation of paper maps and travel guides designed to be used in conjunction with these early GPS models.

This approach can be summarized as the “let’s take a GPS to the map" concept. Printed on these maps and travel guides are GPS coordinates of designated waypoints and critical road junctions. Using a GPS in “GO-TO” waypoint navigation mode (i.e. straight line navigation or ONE-DIMENSIONAL navigation) with these maps providing the general overview, the concept has indeed opened up remote pathways, resulting in ever increasing traffic in sometimes eco-sensitive areas.

The problem with one dimensional or “GO-TO” waypoint navigation was not so much the accuracy of destination waypoints on these maps (although some are notoriously inaccurate), but rather the method utilized in getting to these destinations.

Informed travellers and skilled users of GPS receivers were able to devise GPS routes and then employ route navigation which is indeed the safe and the environmentally correct way of planning a journey in remote or eco-sensitive areas. However, skilful users of 1st generation GPS’s are few and far between, and practically no one now uses route navigation with those non-map enabled units.

The basic problem with 1st generation or GO-TO point navigation is that it offers little or no navigation support in the immediate field of view. For example, you are traversing the mud roads of Moremi or Savuti. Your GPS is in “GO-TO” waypoint mode, which tells you accurately that Savuti Camp is 28.345

km and 45.8282 degrees ahead. You may have combined this with a paper map which is printed to a scale of 1:250,000, offering a nice additional overview. However, when the road suddenly splits into two or three different seasonal tracks, there is now no information available on which to base your choice of route. Neither the GPS unit nor the map can give you this information in such circumstances.

GO-TO waypoint navigation is fine for aircraft pilots and skippers at sea who can travel in straight lines. But for bush navigation the concept has caused many 'out-of-fuel' situations -some catastrophic- and it has also caused irreparable damage to the environment.

The sensitive gravel desert floor of North-West Namibia will carry the scars of 'vehicle track pollution' for the next 600 years because this is the amount of time required for the desert's winds to repair the damage. There are numerous dead-end tracks leading into the unspoiled mountains of Damaraland. This is the result of indiscriminate leisure driving and getting lost situations over many years.

The problem is then made worse where time and time again travellers follow previous erroneous tracks thinking this will take them to a destination point and because the GO-TO pointer on their GPS unit shows this as the correct direction to take. The devastation is so bad it is now visible from satellite photos.

Navigating by means of a route or using a routable GPS map is a far safer and environmentally friendly option. ***To date Tracks4Africa GPS maps are the only GPS maps to offer responsible routing capability in Africa and we take pride in the fact that our routing capability will have a positive effect on the African fauna and flora.***

Track Navigation

Whilst the 1st generation navigation solution is based upon the "let's take a GPS to the MAP" concept, the 2nd generation solution reverses this concept to "let's take a MAP to the GPS".

In the late 90's the market offered 2nd generation or 'map-capable' GPS receivers that comprise robust hand-held GPS units and PDA technology with electronic VECTOR maps installed as background base maps.

Second generation GPS navigation implies "TRACK-NAVIGATION" (or 2-dimensional navigation) as opposed to 1st generation "POINT-NAVIGATION" (or 1-dimensional navigation).

Provided with accurate and reliable vector GPS maps, the new map-capable GPS technology (and track navigation) has made it possible to comply with the golden environmental rule of ***"Let's stay on the beaten track"***.

There are several commercial GPS mapping products on the market today, and these can provide GPS maps for city streets and main roads of South Africa that are remarkably accurate. The latest innovation is auto-routing where the GPS receiver will calculate a route and then tell when to turn left or right, how far to the next turn off and so on.

For rural and remote Africa it is a completely different story. Current commercial GPS maps have accuracies that vary from 250 meters to 4 km because these maps are constructed mainly by tracing road or track lines from available official paper maps, most of which date back to Colonial Africa and which are outdated and sometimes woefully inaccurate. Also used as source material for such maps are tracings from available satellite imagery. These often cannot tell the difference between navigable roads or river beds, cut lines or pipelines, power lines and railway lines and certainly cannot provide information on which roads are mined and those that are safe to travel.

The many dead-end vehicle tracks in the deserts of Namibia (traced from satellite photos, because they are visible on sat-photos) are now displayed on commercial GPS maps as navigable 'gravel roads' and as a result even more people (unintentionally) disturb the ecology.

Second generation (map-capable) GPS technology is only as good as the GPS map loaded to its memory. Accuracy and reliability of the GPS map is the key. Without it, your new 2nd generation GPS is not a safe functional unit.

This is all the more important in these days of mass GPS usage. GPS systems are no longer the preserve of experts, but are used increasingly by the general public. Already, the GPS system is becoming a standard accessory to your new car.

Community mapping

To map remote parts of Africa accurately, reliably and ecologically correct cannot be done by conventional mapping methods (tracing from Official maps and satellite imagery). It will require extensive GPS field mapping projects which will be un-economical. Given that remote Africa is constantly changing, with every rainy season and with every new local political order, it will require mapping and re-mapping.

To construct an eco-map is a ground zero mission and at best the job can only be done by experienced eco-travellers, people with a passion for Africa and its conservation.

There is only one way to map Africa accurately, reliably and environmentally correctly. That is to put the responsibility for the collection of data in the hands of experienced and responsible eco-travellers who know conditions at ground zero.

Common hand-held GPS units offer the functionality to store both WAYPOINTS and TRACKS. The latter is an electronic recording of the actual 'spoor' or 'breadcrumbs', showing the precise roads and tracks that were traversed by the user. There are enough GPS receivers out there and enough IT skills accompanying the many leisure trips to remote Africa to make community mapping work and Tracks4Africa made this work.

What is needed is an electronic VECTOR map that comprises only/strictly of GPS recorded/confirmed data. More important is to have access to a continuous stream of fresh GPS recorded data to update this map, because Africa constantly changes.

In the late 1990's environmental users began to put their GPS systems to good use. To date more than 7million km of GPS recorded track data and 110,000 waypoints were collected and processed according the T4A quality standards http://tracks4africa.com/content/support/3_Standards for Field Data Collection.pdf (584kb)

This provided a huge set of properly warehoused data from countless leisure travels/activities into the safe reaches of Africa. This data repository is known as the 'T4A Vault'. The data set represents the collective property of T4A data members.

Cleaned, consolidated and spatially averaged the 'T4A Vault' yields high quality, super accurate and reliable navigation data. This data is called "T4A Warehouse" and cast into a GPS map called the "T4A GPS Maps". This map is returned to the contributing community free of charge to assist in their travels and to check if their data submissions have been processed correctly. See http://tracks4africa.com/content/support/the_red_and_the_grey.pdf (143kb)

Based on the principles of synergy and symbiosis the Tracks4Africa philosophy of MAPPING AFRICA is both ORGANIC and HOLISTIC. (Gabri Rigotti)

Anyone can join the Tracks4Africa Community by taking up the responsibility to map and model Africa in an environmentally sensitive way.

The 4th dimension of eco-travel

The Tracks4Africa understanding is that there are 4 dimensions to a navigational picture.

- GPS waypoints offer only a 1-dimensional navigation picture.
- GPS waypoints and tracks offer a 2-dimensional navigation picture.
- Geo-features (river, lakes, dams, mountains, contour lines) add the 3rd dimension.
- INFORMATION is the 4th dimension and the most critical aspect of the concept.

Even with the best and most accurate GPS map available, the question still remains; ***What INFORMATION is needed to not expose oneself, one's travel companions, the vehicle and the Environment, to unnecessary risk?*** INFORMATION needed to make informed decisions on the spot.

The informed eco-traveller is well aware that camping at animal watering points in Kaokoland (Namibia) is a NO-NO. To take another example, Himba cattle have adapted, over the centuries, to feed as far as 35km away from water, returning to drink only every second day when heat and dehydration all but overcomes them. This return usually occurs at night fall or even later. In such circumstances, during the last 5 km when the scent of water is picked up by the cattle, the thirsty animals often stampede towards the waterhole with potentially lethal implications for any unsuspecting overnight bush campers. A recent case in point; R 40,000 damage to a brand new 4WD in June 2003, luckily no one was injured on this occasion.

INFORMATION is a fundamental travel need. It is the common denominator amongst responsible eco-travellers to remote Africa. Far more is the need to share information, to learn from each other's travel experiences. It is the driving force behind internet based "Environmental User Groups" and more to come.

To provide INFORMATION and to INFORM (Jan Joubert) are the only instruments to preserve and to protect environment for future generations to do the same.

Most of the eco-destinations are outside the National Parks, Nature Reserves and protected areas as such do not enjoy the relative benefits of research, legislation and control. Moreover many of the eco-destinations in Africa are home to historical, cultural and religious heritage.

Moreover and given environmental impact on specific bio-diversities of a wide range of leisure activities including hiking trails, mountaineering, mountain bike trails, river rafting, bird watching, flower watching, paragliding, bike trails, quad bike trails and eco-travel.

It all boils down the fact that responsibility for protection and preservation, increasingly rests with 'Environmental Users' themselves. It also means that the definition of 'NAVIGATIONAL TOOLKIT' has to be replaced by an 'INFORMATION TOOLKIT'

The basic problem with the current 2nd generation handheld GPS with its screen the size of a match box, it is very restricted to convey INFORMATION.

While GPS maps only allow for limited information to be displayed, Tracks4Africa is now featuring rich content on Google Earth and the intention is to grow this content into a repository of information to travellers. Everyone can contribute to this set of rich content.