South Africa

The Problem: South Africa needs to optimize smallholder agricultural production for national food security imperatives.

Lack of investment incentives in smallholder agriculture, uncertainties within the sector, limited water availability and associated extreme weather events and variable climate such as droughts are major threats to food security in South Africa.

The resource limited, smallholder farmers need usable and near real-time information at an appropriate scale to make decisions on crop planning and production, weather, and climate outlook including maximum and minimum temperature, frost conditions, rainfall and evapotranspiration, vegetation condition, and soil moisture conditions and relate these to different crop requirements.

In order to provide this information, South Africa needs innovative decision support system that integrates space-based Earth observation capability and other geospatial data, in situ and socio-economic data to enhance the capability for the smallholder producers, and risk management for the small-holder farmers, so realizing significant and measurable improvement in incomes and livelihoods.

Context/ Impact Statement

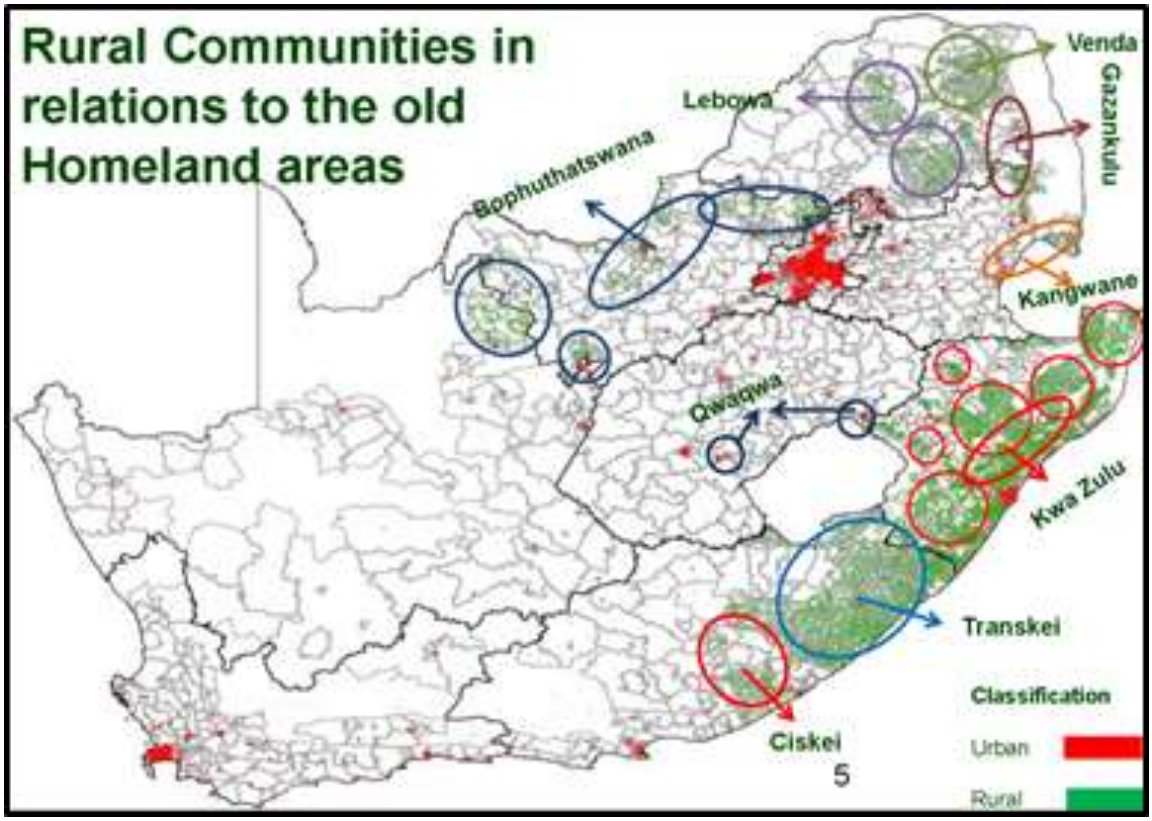
The current project will constrain the geographic area to South Africa for the development of the space-integrated agricultural decision support system, however in the longer term, we envisage upscaling to countries in the SADC sub-region and to the larger African region. The project will provide a monitoring and decision support toolkits for the smallholder (including subsistence and small-scale emerging) field crops farmers in south Africa (approximately 150 000 farmers).

Quick Stats: South Africa

- Area: 1 219 090 square kilometres
- Agriculture: 81.6% of total land area
- Arable land: 12.1% of total
- Irrigated land: 10.15% (1.3 Mil Ha) of arable land
- Total Population: 52 Million
- Agricultural Households: 2.9 Mill (Stats SA 2011)
- Agricultural Water Use: 50% of country availability
  Info source: http://www.southafrica.info/about/facts.htm#.VNiGtvmUfC9

The Spatial Context

This concept proposal seeks to provide a customized space-integrated decision support system to smallholder farmers in South Africa in the rural areas of Limpopo, KwaZulu-Natal, and the Eastern Cape provinces on a near-real time basis. These provinces are considered because they host almost two-thirds of the national agricultural activities (KwaZulu-Natal 24.4%; Eastern Cape 20.7% and Limpopo 16.3%). Additionally, about 1,800,000 agricultural food producer households that fall into the category of subsistence and small-scale farmers who are vulnerable to food and income insecurity reside in the chosen provinces (www.statssa.org). Agricultural production in these provinces is mainly constrained by water availability and a variable climate. A large number of the agricultural households in South Africa depend on Agriculture for subsistence and supplementary food security. The map below illustrates rural communities (where subsistence agriculture is of importance for food security) (source: DAFF / DRDLR, (2014) APAP Spatial Planning: Potential Production., Internal PP presentation).



The challenge

The agricultural sector in South Africa is a dual economy which is dominated by well-resourced large scale commercial agriculture and the poorly-resourced subsistence and small-scale agriculture. The large scale commercial agriculture forms a key part of the formal economy while the subsistence and emerging small-scale agriculture is dominant in the informal sector of the national economy. The agricultural economy is a variegated ecosystem with a value chain that has a multiplicity of role players/stakeholders namely farmers (subsistence, small scale and large scale commercial entities), agribusiness and agro-processors, government departments and agencies, financial services intermediaries, public and private extension services, retail operations, NGOs, research institutions, among others. The players are of various sizes and influence and as a result, the natural flow of benefits is usually proportional though not necessarily equitable. **The challenges that are inherent in the agricultural economy and value chain in South Africa are largely a result of decision-making information asymmetries.** These asymmetries have a far-reaching disadvantageous effect on the active participation of the smallholder farmers in the agricultural value chain because they are the least enabled players in the ecosystem.

Main information need

The project aims to reach out to support a minimum 150,000 smallholder farmer households in three-five years. Seventy per cent of the target beneficiaries will be women. The space-integrated information services to be provided included:

- Crop cultivation, seasonal outlook, and market information;
- Cropland suitability information in the face of changing environmental conditions;
- Geospatial information for soil and land preparation; weed, pest, soil, water and nutrient management; disaster early warning;
- Geospatial and other information in support of marketing, transport logistics, packing, contract growing, market information.

The main information need of the small holder farmers is:

- Crop planning and production, weather and climate outlook including maximum and minimum temperature, frost conditions, rainfall and evapotranspiration, vegetation condition, and soil moisture

conditions and relate these to different crop requirements.
- marketing, contract growing, agri-processing,
- production inputs and financing

It is expected that this project will contribute to 10 to 30 % improvement in production efficiency three to four years of implementation:
- Improved food production by 15% per ha
- Access to insurance and microfinance information by 15% of the current status quo,
- Improve natural resource use efficiency (soil, water, improved soil nutrient factor) by 10% and improved water harvesting and water use of water.
- Improved disposable income by 10%

Information system currently use
The dominant agricultural management systems called Manstrat (Extension Suite online) which is use in South Africa whether by public or private services providers provide static agricultural information. Moreover, there are other private services such as E-leaf (http://www.eleaf.com) and MySmartfarm (http://mysmart.farm/#about) that cater for large scale commercial entities at subscription prices that the smallholder farmers cannot afford. The south Africa Weather Services provides weather and climate data at a cost but this is just information but not advisory services.

The approach
At a national level, the government of South Africa has recognized the need to provide a decision support tool that supports a synthesis of responses to opportunities and/or challenges faced by all agricultural value chain role players with a special emphasis on smallholder farmers. In this regard, this project would be implemented through the provision of actionable geospatial information products on a near-real time basis to address a set of agricultural monitoring at the farm level, the demand and supply side objectives in the provinces of Limpopo, KwaZulu-Natal and Eastern Cape for crops such as maize, beans, sweet potatoes, etc.

Output
The major benefit will be accelerated agricultural development through the increased return on investment and profits by smallholder farmers and financial institutions. The accelerated entry of some smallholder (emerging) farmers into mainstream commercial agriculture will be a major benefit

Improved food security for the small holder farmers, improved income generation, ability to mitigate climate change and other agricultural production challenges

Deliverables:
1. Decision support tool embedded in mobile apps, mobile network *sms* services and web mapping service software
2. Implemented visibility plan
3. Operational well-managed national and international partnerships
4. Report: Collation of existing data, knowledge, systems, relevant current and historic projects and lessons learnt.
5. Business case and Regular review
6. System user needs and design
7. Devise an operational system
8. M&E framework, reviews and progress reports
9. Operationalization and sustainability plan and process.

Knowledge and experience:
1. Scientific and popular publications, user manuals and guidelines
2. The project will reach a large group of food producers (150 000 emerging Farmers), this also includes female food producers and will be trained in using the suit of developed tools.

Impact

The main impact areas are threefold:

- Improved food security at household and country level;
- Improved environmental and natural resources sustainability and;
- Improved the social and economic status of the communities and small-holder farmers.

The specific impacts:

- Change in food security and social and sustainable economic growth for food producer. Small-holder food producer would increase their production by over 10% to 30% in three to five years.
- Poverty alleviation: the system shall provide an opportunity for small-holder farmers to generate income by over 10% and this will reduce poverty in the rural areas.
- Gender issues: The inclusion of women in farming will be increased from 47% to 60%.
- Self-reliance: The system shall necessitate a dialogue between the small-holder farmers and government. Through a public-private-partnership (PPP), the provision of information will be continuous while providing small farmers with access to the markets. Access to markets and continuous provision of the information service, with the revenue generated through the system, shall provide self-reliance of both the system and small-holder farmers.
- Development of new institutional and trade partnerships

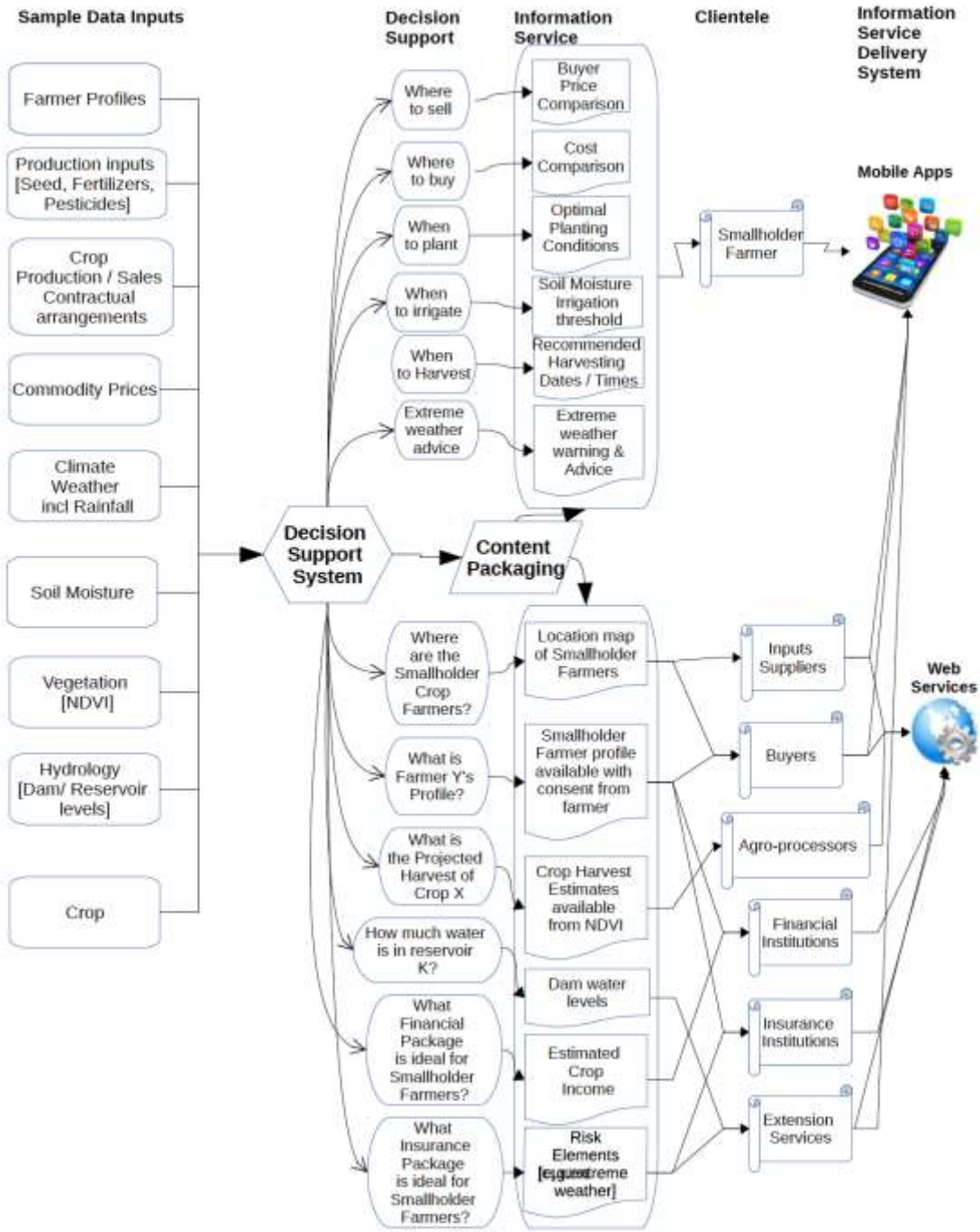
Requirement

Rational for governmental support

The South African government has several programs to support small-holder farmers. The Department of Agriculture, Forestry and Fisheries (DAFF) is mandated to ensure that there is an improvement in crop production in both commercial and smallholder farmers for achieving food security goals. The South African National Space Agency already have an existing MoU to ensure that project proposals such as this are linked to existing programs for supporting small-holder farmers. DAFF is in full support of this program. The Department of Science and Technology (DST) is also mandated to oversee technological development and innovation through its entities, including SANSA. DST's Ten Year Innovation Plan outlines several Grand Challenges, and Space Science including Earth Observation is one of them. Due to this, DST has a fund to substantiate any international funding opportunities.

Implementation of Information Service

The proposed information service will be developed for multiple users. The figure below provides a tentative outline of the information services to be provided to the various user groups. The list will need to be confirmed by the various user groups during the "User needs analysis phase of the project".



Smallholder farmers

Smallholder farmers will require information on agricultural commodity prices, rainfall, soil moisture, pests, financial and insurance products packaged in simple and useful ways that allow them to make quick decisions as illustrated in the figure above.

Financial institutions

This grouping of clients requires information on farmer credit profiles, crop harvest estimates, market contractual arrangements in order to make decisions on farmer financial support and the types of financial products to develop for smallholder farmers.

Insurance companies
Insurance companies require information on farmer profiles, risks associated with weather conditions, and farm products transportation logistics, amongst others. These information services will be used to develop suitable insurance products for smallholder farmers. Further, this client group will require information on disaster events and location to assess insurance payouts to farmers.

Market Buyers
This clientele group requires information services on pre-harvest estimates of specific crops, volumes, the location of farmers, estimated harvest dates, farm gate producer prices, and contractual arrangements, amongst others.

Extension Services
This group of users will require a range of information products including soil moisture maps, vegetation indices, yield estimates, dam levels. Extension service providers will use this information to obtain a regional picture of the areas they work in and assist farmers accordingly.

Satellite information need
This project proposal will use Earth observations (remote and in-situ) for improved decision making and advances the societal benefits of Earth Observations mainly in the (GEO Societal Benefit Areas) of Agriculture and Water. The provision of satellite data is fundamental to the project and the operationalization. Product generation can only be achieved by using satellite data, because of its wider coverage and temporal capability. The use of high and coarse spatial resolution – multi-sensor approach will be adopted to counter issues of cloud and unavailability of data. Targeted high spatial resolution data include Landsat 8, SPOT 5/6, Sentinel-1/2 (5 to 30m) and low or coarse resolution including MODIS (250 to 1000m). The high spatial resolution data will be used for calibration and validation, while the high temporal but coarser spatial resolution will be used for monitoring and forecasting purposes. The main role of the satellite data is for
1) Derivation of indices – crop or vegetation, soil and drought indices.
2) Retrieval of biochemical and biophysical variables, critical for the modeling exercise.

Satellite data has been successful in estimating mapping variables such as chlorophyll and leaf N for crop condition assessment, evapotranspiration (ET) and soil moisture for irrigation scheduling, leaf area index (LAI), fraction of photosynthetic absorbed radiation (FPAR), albedo, and radiation as critical inputs for ET estimation. These variables are useful for modeling and to inform decisions pertaining to:

- What to plant?
- When to plant, and when to irrigate and fertilize?
- Detect crop stresses due to pest or weeds
- How much is the possible yield?

Training and capacity building
This aspect of the project advocates for capacity building as a support platform necessary for the development of space-based agricultural information service. It will capture views concerning what farmers would like the tool to do, and campaigns to get farmers to use the tool (uptake of the products). Existing Technology Transfer models for ARC are going to be adopted and customized for these campaigns: (use of formal training, seminar and workshop events with communities). Workshop series will be focusing on getting a sense of what the client needs and the platforms upon which the services/information can be delivered to them, demonstrating capabilities and advantages of the tool.

Synergy with bilateral and international programmes
The project team sees opportunity in synergizing with a number of international, regional and bilateral initiatives and programmes. SANSA and a number of government agencies and science councils are active participants in GEO activities and tasks, exposing them to a number of international initiatives. These include the GEOGLAM and GEOGLAM RAPP initiatives of GEO (www.earthobservations.org) where this project can provide country information to the global crop and livestock production estimates.

The mission of AgMIP is to significantly improve agricultural models and scientific and technological capabilities for assessing impacts of climate variability and change and other driving forces on agriculture, food

security and poverty at local to global scales. To enable this mission, the goal is to create a next-generation knowledge platform for agricultural modelling worldwide (http://www.agmip.org/). This international initiative is active in South (and southern) Africa and has been identified as having synergy with the proposal. The ARC is involved in the local (southern Africa) component of the AgMIP initiative and will facilitate the synergies.

The project will also synergize strongly with the "Monitoring of Environment and Security in Africa" (MESA) programme that has as aim "to increase the information management, decision-making and planning capacity of African continental, regional and national institutions mandated for environment, climate, food security and related responsibilities by enhancing access to and exploitation of relevant Earth Observation applications in Africa" (http://www.eumetsat.int/website/home/AboutUs/InternationalCooperation/Africa/MonitoringofEnvironmentandSecurityinAfricaMESA/index.html). Consortium members of this project (ARC, SANSA) are already involved in the MESA (SADC) component of the programme.

The Tiger-Net component of the ESA Tiger initiative aims to support the satellite-based assessment and monitoring of water resources from watershed to cross-border basin level delivering indispensable information for Integrated Water Resource Management (IWRM). The systems emerging from this initiative and the capacity building opportunities offered will prove valuable to the project and consortium members involved in Tiger-net (SANSA) will ensure synergy with this initiative.

A relationship with The Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN) will be established so as to capitalize on projects and programmes that are being undertaken by this network and its consortium partners. The ARC is an active participant in FANRPAN and will facilitate synergies where feasible.

South Africa, as a member of SADC is active in the various SADC programmes relating to agricultural development and the use of natural resource information. Exploring synergies with these will be an activity of this project in the early stages. The SADC Multi-country Agricultural Productivity Programme (MAPP) being an example.

Synergy with activities of the various CGIAR institutes will be co-ordinated by the involvement of the International Water Management Institute (IMWI) as a partner in this project.

The Sustainability Model

The viability and economic sustainability of the system and services will be based on a variety of revenue streams. These include agri-processing enterprise subscription, the proposition to offer mobile network operators a subscription package targeted for their respective markets, a commission from input providers, production input suppliers advertisements and government extension contributions (subsidy). The Partnership will also engage other local and international funding institutions for financial and technical support and more importantly to leverage on aligning projects and/or processes of mutual and synergised nature to diffuse cost or eliminate the duplication of costs and/or activities and processes. This synergizing is especially significant as DAFF and some provinces as well as some private sector initiatives are developing spatial information systems and web-based map services. Few, however, are considering the delivery of decision support information directly to the emerging and subsistence farmers (the last mile concept). The project proposes a Community, Public, Private, Partnership (CPPP) business model, with various processing nodes.

Data acquisition and pre-processing

Earth observation data will be collected using multiple sensing platforms. SANSA is the custodian of most Earth observation data in South Africa. The agency carries out data acquisition and provides data pre-processing services to government institutions. The cost of data acquisition, pre-processing, and modeling is covered by a combination of government grants and cost recovery through the sale of value-added processed products.

In addition, in situ field data will be collected by community partners, i.e. smallholder farmers using mobile gadgets, e.g., cell phone cameras. Extension staff will supervise the data acquisition and upload of the images collected. A number of alternative affordable mobile gadgets will be tried to determine which one will be fit for use. We intend to work with a mobile services partner willing to provide the means to upload data by farmers free of charge, i.e., without the farmers having to carry the cost. We envisage the valid upload of data

being rewarded by points that can be redeemed for farmer production inputs discounts. The exact details of how this will be implemented will be determined during Foresight and Innovation workshops. This approach has been applied in the Water, Biotechnology, Nuclear, Rural Development sectors with impressive results.

Revenue Model

Private sector partners will recover costs and make profit through the following sources:

- Sponsorship grants from interested public institutions like DAFF, DST, and DTI;
- Advertising space on websites and mobile applications.
- Subscriptions from interested parties consuming and making use of farmer information for decision making, these include buyers, financiers, insurance brokers, commercial farmers, etc.

Ownership and revenue distribution will be negotiated and consolidated through the facilitation of the NIPMO, a South African government agencies set up to provide PPP Consortia Intellectual Property arrangements. Ownership of the data and operational responsibility will primarily rest with government institutions such ARC and SANSA.

Model Differentiating Factors

The proposed implementation model provides for a viable, self-sustaining business ecosystem where the principal client, smallholder farmers obtain a no cost mobile information service, which is primarily financed by the advertising and subscription fees obtained from commercial private sector users (inputs suppliers, agricultural commodity buyers, agro-processors, financiers, insurance companies) who have a vested interest in the agri-business which has the smallholder at the centre as the primary producers. Furthermore, the participation of farmers in not only accessing information but the provision of input data critical for models calibration of Earth observation data provides for a win – win situation where each member along the value chain has an interest in keeping the system functional.

Sponsorship revenue will be sourced from entities with an interest in the long-term success of smallholder agriculture. These include government departments like the Department of Agriculture, Forestry and Fisheries, and private sector agri-business food processing companies.

Advertising revenue will be obtained from advertising space sold to parties with an interest in the exposure of their products and services to smallholder farmers. These products will include but will not be limited to seed, fertilisers, logistical services, and insurance products. Care will be taken not to overwhelm information system users with spam and advertising by keeping farmer contact information confidential, not allowing pop up advertising messages, and auctioning tightly controlled limited advertising space to advertisers.

Subscription income will be sourced from parties with an interest in regular access to packaged information generated through data modeling and information integration components of the value chain. The packaged information will include information on prices, projected yields, futures markets, and farmer profiles.

Acceptability of the service/solutions

The approach proposed to ensuring acceptability of the information service is anchored in the direct participation of the user community in co-creating the nature and character of the information service and specific product. Using a foresight driven approach we will work with user segments to identify and define the products from the user perspectives. This approach facilitates the direct connection between the user aspirations and vision with the required functionality provided by the system, thus eliminating the need to "sell" the system to users.