Responding to Climate Change - Knowledge Management

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Abstract

For data exchange about climate projects, science and economics, information models are absolutely essential to deploy public information sharing by geographic location.

The deployment of real-time global climate information sharing can provide dissemination of local knowledge from hands-on experience, as well as established climate science. Most countries are responding to climate change with specific activities addressing agriculture, horticulture, silviculture, and aquaculture as well as improvements to local ecosystems.

There is a unique opportunity to provide real-time geographically connected data for a wide range of climate mitigation/adaptation/remediation activities, fostering collaboration and knowledge-sharing of solutions for particular problems in respect to maintaining human habitat while enhancing regional biodiversity.

A common climate information model can ensure application of climate science, and economic data in the context of climate projects, by ensuring that local and global knowledge is widely, publicly accessible. This common model is essential to ensure the rapid delivery of climate related information. A standard software-as-a-service (SaaS) cloud-hosted approach accelerates development of information dissemination to people and organisations involved in addressing climate adaptation, mitigation, and risk and disaster management

Human timescale (rapid response) data exchange depends on using a combination of high speed search technology indexed by a common information integration model. This is an efficient and effective way to deliver meaningful global climate information from distributed Information and Communications Technology (ICT) cloud data centres.

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Overview

Interoperability is the key to exchanging information amongst members of the public, climate professionals, governments & civil society.

Greenhouse gas emissions reductions scenarios, and energy efficiency savings algorithms can be applied to climate project finance applications, automatically. This means that for projects addressing climate change, the costs and benefits from emissions reduction and energy efficiency can be determined in terms of relative effectiveness to addressing climate change risk.

So that data from different sources can be easily referenced, there is an urgent requirement to standardise information access to climate science and local environment knowledge. With ICT technology, and common climate taxonomy, climate knowledge management and data exchange can be facilitated on a geographically distributed basis.

Climate Data Exchange has to have the following characteristics:

1. Ability to publish and subscribe to information about climate information topics.
2. Ability to provide a standard set of search terms and a facility for online mapping of information to these search terms.
3. Ability to connect to high speed online search capability.
4. Ability to query, access and aggregate multiple data collections in near real time
5. Provision of online workflows to lodge climate project applications for finance, connecting climate project, science and finance specialist project evaluation.
6. Automated decisioning to connect emissions monitoring and energy efficiency calculations to climate project application scenarios for evaluation purposes.

The common climate taxonomy that can provide access to scientific and project data collections has to be objective, informational, and enumerative. It can also cover project related greenhouse emissions reductions, and energy efficiency calculations.

Cloud ICT semantics can be automated from well-designed models. Connections between project location-based data, such as climate, farming, water supply and weather, can be cross-referenced to, and presented with relevant climate science, research papers, and classification systems. Complex information search can be facilitated by web workflows.

As well as guided search by topic, web role-based interfaces can provide climate stakeholders with secure access to relevant climate project application and approval workflows, enabling specialists in different locations to contribute their expertise to project, scientific and financial project assessments and governance.

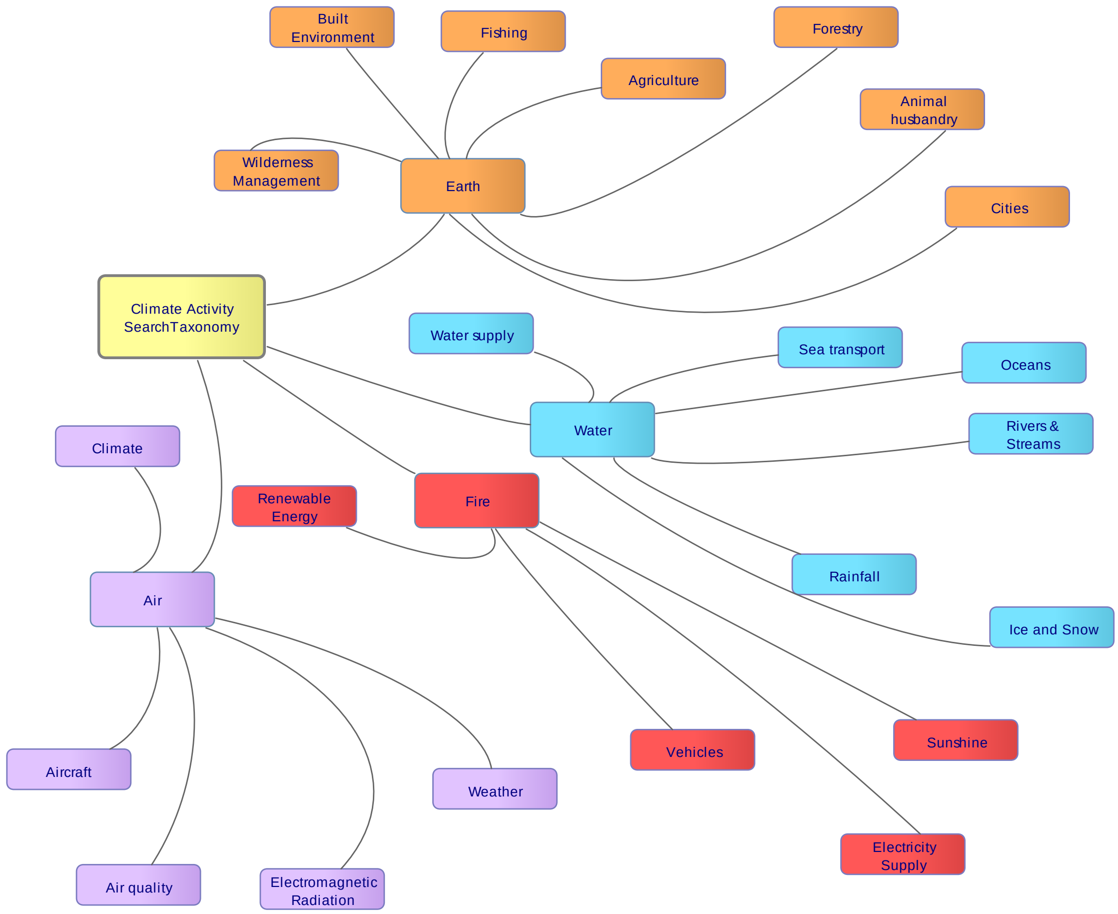

Figure 1: Conceptual high level climate activity search technology

An Information & Communications Technology (ICT) cloud can facilitate both taxonomic (categoric) and free text search in near real-time across international, allocate-to-order, flexible data centres where capacity can be scaled up to meet demand.

Deployment of climate search taxonomy is the starting point to provide the common factor that accesses diverse information from different sources, with varying degrees of complexity. Different types of information can be searched for, selected, and used in online data analysis, depending on the context of the climate workflows , e.g. project, science, environment, weather, economic data analysis, etc.

The ICT cloud technology is automated from UML (Unified Modeling Language) models, deploying high-speed search technology, data integration, event processing, data centric messaging, and databases (including big data as required), on public and private cloud data centres, which can be located anywhere in the world.

To decrease climate risk, there has to be an increase in the human, technology and financial resources required to address climate change. Accuracy of estimation of costs and benefits is key to effective allocation of resources, (particularly financial) to projects.

Exchange of climate data is key to managing the goals of addressing climate change, including the reduction in greenhouse gas emissions and the increase in energy efficiency associated with successful projects addressing climate change.

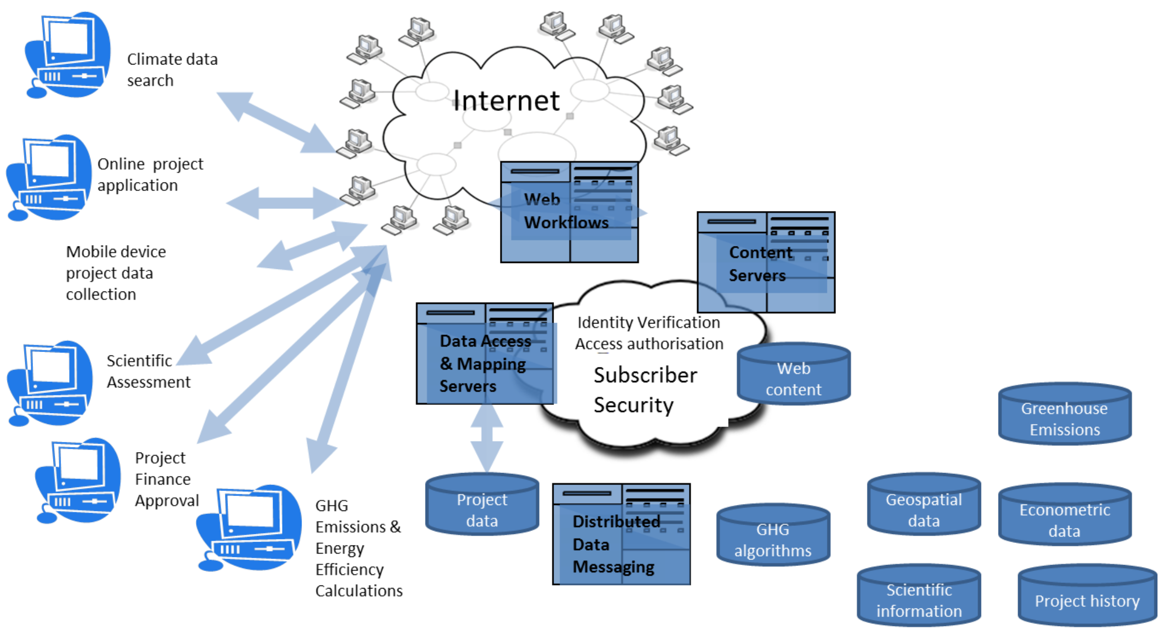

Figure 2: 'Climate Cloud' Overview

Climate data exchange can decrease risk to human cultivated and built environments as well as wilderness, oceans and alpine regions. To bridge the gap between financial analysis, climate science and local environment knowledge, use of the internet and cloud technology can provide a rapid response to enable public access, as well as knowledge management for climate scientists, project managers and economists.

This common climate model can provide the bedrock for the delivery of climate finance.

With best practice ICT technology, built around a common, platform-independent information model, standardised interoperable messages can be exchanged in a global, location-based context for information delivery, displayed geospatially, and powered by distributed data centres.

Existing scientific and economic data models can provide the reference metadata for mapping to a purpose built climate search taxonomy in a real time geospatial context.

Climate project applications can have algorithms and calculations applied to provide quantitative measures for emissions reduction and energy efficiency potential. These figures can serve as cross-reference information for manual country based greenhouse gas emissions estimation processes.

Synchronisation of data definitions, through adherence to a common model can optimise technology services by simplifying the systems interfaces required to aggregate data from different sources, formats and geographic location.

Interoperability of data can be facilitated by providing web interfaces for mapping public and private climate relevant data, statistics, and anecdotal information by relevant organisations.

A 'Climate Cloud' knowledge management facility, paid for by subscribers, can provide workflows for government and non-government organisations, as well as delivery of information by topic automated by high speed search and data-centric messaging accessing distributed data collections.

Figure 3: Climate Cloud Business Model

Geospatial data standards can play a fundamental part in harmonising information flows. Location can provide a key metadata reference. Location accessible data can provide a register for climate related information assets, as well as stakeholder organisation data subscriptions.

To connect existing climate knowledge management data by geospatial location, organisations can be invited to register their data with the 'Climate Cloud'. Access to anecdotal evidence and intelligence about climate science, economics and projects emissions reductions and energy efficiency can be mapped geographically.

By facilitating conversation and information exchange from the same common information model, peer group circles of climate project stakeholders, scientists, and economists can facilitate a coordinated efficient, effective response to climate change.

ICT Industry Wisdom

It is essential to learn from the current situation, where ICT applications and data all-too-often cannot talk to each other without a large, costly and time-consuming effort. To avoid this situation, a Common Information Model for registering and searching for climate data and knowledge management has to be the first step in building global climate information dissemination. This is because ICT cloud search, messaging, and analysis common data structures are easy to set up prior to building the technology, but almost impossible to reverse engineer and retrofit, once technology is built, as it requires all information to be integrated retrospectively. As there is already an enormous collection of climate related information residing with organisations in every country, a well-designed information architecture is the first step in promoting climate knowledge management. Omission of this step means that information sharing is going to be further complicated, not simplified.

Geospatial location-based data enables relevant stakeholder groups to narrow information searches, and share climate intelligence and aggregate greenhouse emissions reductions from projects. Correctly implemented using a common model, geographic data analysis, can become widely accessible. 'Climate Cloud' subscribers can use simple, clear online processes for exchanging information by publication and subscription to selected climate topics.

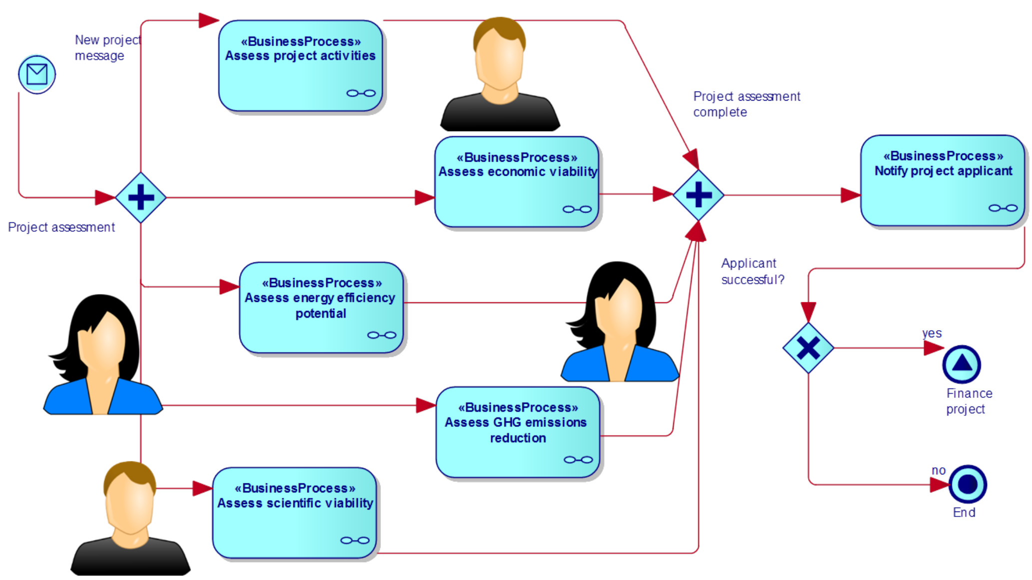

Figure 4: Web climate finance and project assessment workflows

In addition to publishing climate project, science and economics data, one aspect of addressing climate change cannot be overlooked, and that is the ability to collect and publish accurate data for monitoring greenhouse emissions reduction potential from climate projects. In addition to current emissions reduction scenarios, improvements can be made by developing new emission monitoring algorithms for new climate mitigation and adaptation projects, as they emerge.

Publication of climate information across national boundaries allows stakeholder groups, to make use of large volumes of data for intelligent analysis of efficient and effective ways to meet countries' emissions reduction targets and ambitions.

Knowledge Management

Regional, national, and international responses to climate change are challenged by the scale of climate information sources currently available. Accelerating supply and demand for high quality climate change information does not meet current, let alone future needs. Accuracy can be improved by utilising data collected in real-time, in view of the temporal urgency expressed in UN IPCC climate change reports**.**

The best way to proceed is to start with standards that are already in place, then extend them to provide a common terminology, not only for climate science but also greenhouse emissions reduction and energy efficiency. This represents a paradigm shift in current thinking and practice. Information interoperability cannot be defined simply by a data model and web services. It has to be demonstrated in the context of a global search facility able to exchange high speed, real-time messages containing climate data, metrics and anecdotal evidence.

Geospatial analyses of climate data insight can be made accessible in near real-time. Responding to climate change information is of interest, not only to government and non-government organisations, but also to industry and households. All parties are going to have to participate in energy efficiency, and greenhouse emissions reduction, to achieve climate change risk management goals.

To integrate response to climate change information, means being able to efficiently integrate geographically diverse information from distributed information sources and networks, only possible with a common parlance for automated data distribution, and workflows. Peer group collaboration and co-operation for sharing climate intelligence across organisation and national boundaries can be established using the same common climate model. In fact it is essential to use the same model to be able to access diverse information across scientific disciplines, project types, languages and cultures. The basis for sharing information is not to standardise the information, but to provide taxonomic, categorised access so that organisations can register their own data collections in their own language.

Analysis of climate cloud data can provide cost-effective energy efficiency, as well as greenhouse emissions reduction metrics in a geospatial context. In fact this is essential to meeting the situation of global knowledge sharing of CO_2e reduction targets.

Time is running out to address climate change financial and environmental costs. To proceed, it is critical that there is no tower of Babel. Now is the time to build the common information model, to accommodate existing and new standards and terminologies. And even more importantly, now is the time to recognise that an efficient and effective technology for an automated energy data exchange must be an international collaboration amongst diverse stakeholders.

Agreement on semantics cannot be the province of standards bodies only. It is too complex for theoretical approaches to produce a completely useful set of semantics. Semantics have to be developed in the context of the ICT search and messaging technology. Common terms can be agreed by stakeholders as input to the development of a common climate model exchange technology approach.

Approach

There are any number of approaches to providing ICT solutions to integrate Climate Cloud information with geospatial and climate data for mitigation/adaptation/remediation purposes. If these solutions are not synchronised, there can be no effective information exchange across national boundaries.

For an interconnected response to climate change, an efficient and cost effective solution can be developed for information access workflows and data transactions. Historically, excessive ICT costs and schedule overruns have been incurred almost without exception by integration requirements for semantically incompatible data.

The core ICT technology required to mobilise a cost-effective ‘Climate Cloud’, is a common semantics-based data integration, complex event decisioning, web content delivery technology platform, communicating with geographically aggregated, data-centric high speed distributed, real-time messaging for publishers and subscribers.

The characteristics of technology providing data exchange based on common models is able to

1. Connect different technologies across Climate Cloud ICT data centres in real time
2. Easily deploy on current cloud technology integration platforms, networks and infrastructure
3. Reference common vocabularies and protocols.
4. Access and utilise geospatial data overlays and infrastructure from existing geospatial standard

Background

Crystallised by the report 'Climate Change 2013 – the Physical Science Basis' AR5 published by the Intergovernmental Panel on Climate Change (IPCC), governments and non-government organisations can no longer debate the critical level of risk from climate change with any credibility. It is also clear the preponderance of glaciers are melting, and that sea-level rises have a lag factor lasting over a century even after the necessary reduction in global greenhouse gas emissions to address surface, air and ocean temperature rises.

Responding to climate change requires large scale finance for project activities that provide climate change adaptation, mitigation and aid for communities post extreme weather events.

Scientific, economic and project specific local knowledge is being gathered at accelerating rates, and yet the systems for distribution of climate related information is facing the same serious challenges that large scale corporate ICT (Information and Communication Technology) is finding so difficult currently. Today's major challenge is information overload, and inaccessibility to relevant contextual information in human response time, because of the sheer volume of information being collected.

Semantic harmonisation of knowledge depends on co-operation and collaboration amongst disparate stakeholder groups. The level of co-operation required to facilitate global data exchange is sadly proving currently elusive in ICT intensive industry sectors.

To learn from the private sector's mistakes with ICT developments, establishing an initial collaboration at an international level is imperative. The nature of the initial collaboration is the development of a common taxonomy for access to climate change information, and a joint effort by disparate groups and organisations to register their data collections in a consistent manner to a common climate information model.

The reason that this has to be an initial effort, is that current integration technology experiences cost overruns, and failure to deliver, often rooted in lack of common semantics. It is essential to sort out a standard information approach to responding to climate change, and a common information model deployable on best practice technology before building any specific applications. This is the only way to ensure the shortest possible time frame for sharing climate information in view of the urgency of global climate change challenges.

Interoperability of Services

What is required is a set of common ICT services for exchanging data, designed to facilitate information exchange between all categories of stakeholders. 'Climate Cloud' ICT technologies have to be specified in an industry standard way with an industry standard information model.

The OMG (Object Management Group) UML (Unified Modeling Language) specification has been in existence for around 20 years, and it has been designed and developed for the sole purpose of specifying ICT systems architecture and design in a semantically consistent way.

The OMG DDS (Data Distribution Service), and DDSI (Data Distribution Service Interoperability) Specifications provide for a distributed global data space for high speed messaging and semantic interoperability over a wired network protocol.

A geospatial context for 'Climate Cloud' infrastructure is essential to enable international knowledge management and dissemination. The European Commission geospatial standard INSPIRE, provides not only geospatial data and infrastructure, but also a community geoportal is currently being developed, to provide real-time geospatial context.

Adhering to these and similar standards is the basis for ensuring interoperability of climate data messaging, thus providing easy access to subscription/publication services around common climate topics for dissemination of climate information to every interested public and private organisation and individual stakeholders.

ICT Advances

New ICT paradigms have emerged in recent years, including common "cloud" infrastructure, automated semantic interoperability, web federated and low latency real-time messaging services, smart wireless devices, next generation IP networking, federated web content delivery and complex event processing.

The context over the next five years is further rapid development and growth of 'cloud' computing. Cloud technology is about secure sharing of low-cost standard software, hardware and network infrastructure services, in high performance data centres.

What is required to take advantage of ICT advances, is an approach that supports the current and emerging standards of high speed event technology automation, able to connect diverse new and existing climate information technology and data.

UML integrated Model Driven Generation (MDG) Platform Independent Modeling, employing best practice Model Driven Architecture (MDA) and design, is a cost effective, rapid way to develop search and access to existing climate facilities, systems, and data. UML models can also provide a development accelerator for integration of existing capability with new climate workflows, web information access, real-time complex event handling, and data and message integration on a distributed technology grid, accommodating current and emerging climate information models.

Sharing Climate Data

Climate data exchange requires best practice automation of a common climate information model (including search taxonomy, information categorisation, and publication/subscription message topic definitions) into high speed, scalable cloud technology.

Coverage of message publication and search for climate topic subscription has to be able to logically connect the disparate climate information elements with end user access in near real-time.

This implies cloud services supplied by public and private data centres high performing, low cost infrastructure to meet the needs of stakeholders, including access to very large volumes of information (known as ‘Big Data’).

Challenges

The timeframe, to develop a common approach to knowledge management is quite short. Any delays in development of common climate information models means more difficulty and expense integrating response to climate change information from stand-alone, non-integrated applications and databases.

Efficient, geospatially aware climate change knowledge management requires model technology automation of high speed real-time event handling in a multi-party semantic communication framework.

These ICT services have to be developed in the context of distributed, allocate-to-order real-time infrastructure performance from connected, distributed data centres hosting cloud technologies.

Common climate model exchange technology has to go to the next stage of automation evolution. It has to create a communications paradigm shift, with all stakeholders as information suppliers, and all stakeholders as information consumers, facilitated by publication/subscription common topics, search terms and broad brush high level climate information categories, available to all organisations to register their data.

The ‘Climate Cloud’ also has to meet many of the ICT challenges of mobile networks data integration, requiring an advanced flexibility and growth capability, able to connect and upgrade smart telemetry and mobile device interactions, capable of adding new functionality without redevelopment.

What is required to meet these challenges, is a collaborative, co-operative effort by interested parties in a distributed, model-led, semantic, integration capability based on a deployable common geospatially aware climate information exchange model that connects and accesses all registered climate databases, and applications.

The technology required for this ‘Climate Cloud’ can be summarized as complex operational event processing of manual and automated workflow services, deployed on scalable network and server infrastructure, in the context of delivering finance and project governance to eligible responding to climate change projects.

Information has to be made available, accessed and exchanged by different stakeholder groups, government and non-government organisations and civil sector businesses and community groups, securely and quickly.

Technology Solution

There are already interface, communications and data and infrastructure standards in place, developed by various global standards organisations. These standards include distributed messaging automated from UML models.

Climate information exchange technology can readily be achieved with best practice ICT in a collaborative, concerted effort amongst Responding to Climate Change and Information and Communication Technology stakeholders.

Geospatial Awareness

Location-centric geospatial data and infrastructure is a significant advance for the cause of interoperability for a ‘Climate Cloud’ knowledge management capability. It is important for artefacts to be included as standard overlays with the Inspire, ISO and OGC initiatives.

Design of the common climate information model to be primarily accessible by geospatial location is a key to high speed communications. Geospatial definition facilitates high speed distributed data processing, and of course data is much easier to filter by geospatial context with local maps and local information displayed visually.

Conclusion

A common climate information model deployed to best practice data exchange technology, developed collaboratively, amongst key stakeholders, is a cost effective way to ensure sharing of climate data with an ICT ‘Climate Cloud’.

Further development of, and extension to existing climate information models can provide the common taxonomy to underpin standard search, publication and subscription topics, and message interfaces to global sources of climate related data.

Intelligent analysis can then be developed to publish global climate metrics for input into solutions for addressing local climate change challenges.

Greenhouse gas emissions monitoring algorithms for the estimation of greenhouse gas emissions avoided and energy efficiency generated can be applied to recognised climate project scenarios. New algorithm development can facilitate new methods for determining the best returns for investment of climate finance for reduction in climate change risk.

Accurate data can provide input into an effective and working price on greenhouse gas emissions, since current data inaccuracies have put downward pressure on carbon market prices. Current estimation techniques and algorithms may be improved by cross referencing to metrics produced by GHG emissions reductions on a project by project basis.

With statistically significant samples of data, effective policy making can be better facilitated and supported for specific project types in view of the interconnectedness of global weather and climate systems and ecologies.

A pilot project for developing a common climate information model for deployment to a 'Climate Cloud' is an obvious starting point.

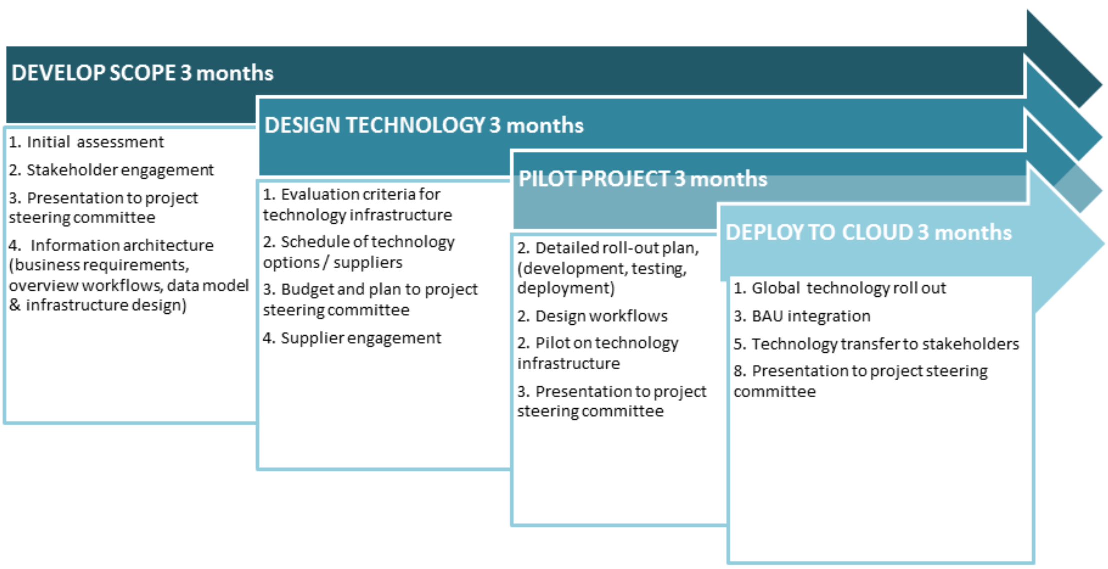

Figure 5: Indicative timeframe to develop 'Climate Cloud'

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