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Geo-Data for the Sustainable Space Building Design

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ABSTRACT

The geo-data by the cyber science requirement allows to manage the ground segment in the harsh context to provide the inputs to design the sustainable building. The methodology from the administration office of Space center in Dubaï demonstrate the computation needed and the data-sets from climate context to produce a position and time from navigation constellation to determine the right location to build a green infrastructure from the passive house certification. The process take account of geo-data approach for computation, the data sets of local climate, and the passive house certification application. It demonstrate that it shall be possible to built building in harsh context without to be connected with the urban grid. The methodology shows that the Space segment is useful to support the ground segment to apply the multi-dimensions aspects of the technical infrastructure from sustainable energy management. The administration office of Space center in Dubaï provide a model to be applied to build sustainable building in harsh climate conditions.

CCS CONCEPTS

Geo-Intelligence

KEYWORDS

Geo-Data, Cyber, sustainable, desert, Space infrastructure

1 The Geo-Data computation

The geo-data computation combines the GNSS constellation inputs to fix the position on the ground by the coordinates. The position, navigation and times provides the location. Then, other datas needs to be collected from sensors to complete the position. It concerns the climate context of the futur building by model in the past and the one in the futur [1].

Figure 1: **PHI Building in Space center Dubaï**

1.1 The climate data-sets from Space segment

1.1.1 The Space constellation tools

The constellation used to locate a sustainable building depends on the context on the ground.
The first is all sensors linked with the observation of the ground. It take account on the imagery, the tele-detection, the meteorology, the quantum techniques. The goal is to collect data to understand the environmental workflow features on the futur site. This point shall provide the sustainable area taken account the materials to be choosen and the design to be applied for the building. The imagery gives the framework on the site within there are the identified objects useful for the design. It could be a river, a village, the geo-morphology.
The tele-detection offers the inputs to determine within the framework the properties of the area. These inputs link the area with the potentiallities to use the workflow on the way in the zone. It could be the water, the wind, the humidity, the heat on the ground, the identification of the cycles, the effects on external factors on the workflow. The precision of the ground properties should be improved by quantum sensors to help the geophysical work to study a site.
To improve the acknowledge of the site, other sensors should used thanks to GNSS system available in the area : EGNOS, Galileo, Beidu, Glonass. The purpose is to fix the location according to the data from the other sensors.
The GNSS inputs give the precision of point the building : the orientation, the position and the understanding of the harmonic coordinates providing the full capacity of the site on terms of the sustainability. It means to be able to produce much energy through the local context : area, the worklow on duty, the interaction to be exploited.
It also means the geo-data computation gathers several parameters to produce the sustainable index to use the potentiallity of the location. The parameters can change with the context. A building in the middle East are not the same in Europe, Asia, Africa and America. The social science intervenes in the analysis process to maintain the connection with the way of the societies in their environment.

The geo-computation should provide the inputs for the formula to determine the index of the location.
For the coordinates of the location, the GNSS should be used through the receivers. Except the coordinates depends on the value of the workflow in process on the ground. Once the value identified, the GNSS receiver on the ground provides the position linked with the index of value.

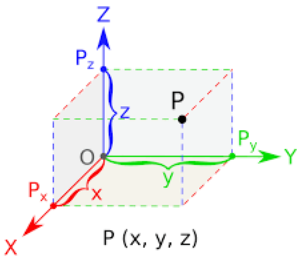

Figure 2 : **theory space for the PHI building**

The figure 2 gives the space where the building should be built according to the preliminary analysis of the sustainability from the location [2].
The P(x,y,z) is the space parameter. In the use case of the figure 1, the orientation of the building is fixed with the measures planned. The modelling is included in the software simulation after the observation phase. This phase comes from the pixel from the satellite. Thanks to digital value from the matrice, it shall display the content of the light to underline if the position gets an index to be exploited for the design of the building : the humidity of the soil, the heat of the ground, the sunlight and its orientation. The proximity of solar panels close to the building is a requirement for the GNSS position too.

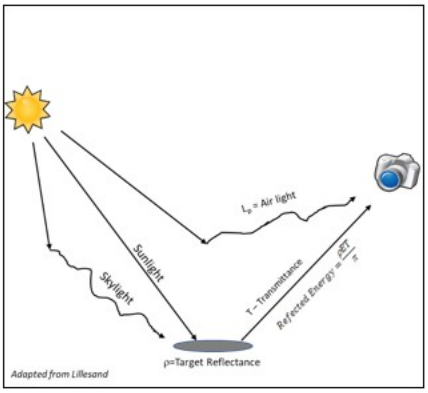

Figure 3 **: sunlight index**

the instruments of the observation satellites give a quantum efficiency to collect photons to improve the target reflectance to analyse the features of the soil.

1.1.2 The PHI certification
The location has been chosen thanks to the Space segment with an add-on for the workflow on the ground. The design of the building is able to be engaged through the criteria of the place. First, the climate is specific because of the heat requires to refresh the building due the IT equipment inside. To maintain a sustainable temperature, the passive house certification shall follow the requirements to realize passive houses in very hot and humid climates. The U-values is a key parameter to design the building. This U-value takes account of the outside air and the components for windows of the same inclination. The other parameter is the EnerPHit [3].
The U-value is defined by the thermal transmittance measured by the heat transfer through the matter. The criteria of the European EnerPHit standard are :
- A heating requirement of less than 25 kWh of useful energy per m² of energy reference area per year,
- Total primary energy consumption (all uses, appliances included) less than 120 kWh per m² of energy reference area per year,
- An air permeability of the envelope measured under 50 Pascals of pressure difference strictly less than 1 per hour,
- Indoor overheating frequency (> 25°C) less than 10% of the hours of the year.
In the warm climate, the condition to apply these requirements need specific inputs to compute the data target of the EnerPHit.
These parameters are included for the roof, the basement floor, the exterior. This produces an energy optimization thanks to the bio-climatic analysis. For example concerning the roof, a photovoltaic system, placed on a timber wood sub-structure, serves as shading screen to a shaded courtyard, which is overlooked by the principal internal rooms. And for all building a 40 kWp photovoltaic field and a 25 kWh electric storage system are provided.
The geo-data computation approach introduces a strategy risk management to follow the real-time behavior of the building. The data shall merge the result of the location and the performances expected. It means the design needs a risk management for the users, the techniques, the conditions of the building organization.
The risk identification is linked with the specific threats of the building : fire by the temperature, the cooling system failure with an effect on the IT equipments.
The risk assessment gives a grid to be applied for the requirement of the building.
The monitoring is made by sensors to display the values expected for the behavior in the passive house context.

2 The passive house

2.1 The muli-dimensions aspects

2.1.1 The sustainable energy management

The cyber science defines the capacity to study and to apply technologies for any purpose to solve a operational issue. The cyber means the understanding of the machines and the interfaces with societies. It mixes the complex interaction between social science and the matters information theory in order to produce the right technology design to sustain the ground segment.

As the life condition is going to change, the requirements appear to sustain the economic development within an ecosystem not fully compliance with human body. And the matters information theory helps to provide the interaction existing in the environnment to use it to sustain life by energy production. This cyber science is included in a risk management to ensure the continuity of activity.

In the harsh context, it may be possible to create activities as demonstrated by the UAE model of a sustainable autonomous home in the desert in Dubai by the Mohammed Bin Rashid Space Centre (MBRSC) [4]. The Sustainable Autonomous House model at MBRSC condenses moisture generated by cooling systems and implements management processes to produce water, which can be used for domestic tasks. This avoids the traditionnal cooling with much energy. The temperature can be maintained between 22°C and 25°C with a system able to limit the energy consumption through a cooling technology based on chilled water, thermal and air insulation techniques in both directions as fresh air spreads across the house through a mechanical ventilation.

The cyber design includes a management and control system which interacts with external heat and humidity fluctuation. Then, the energy available in the building is used for computers and communication technology. Moreover the design include system of sensors for monitoring to follow the real-life behavior of the building. And the position and the orientation of the building uses the climate data set of the place for the heating and cooling design. At last, the IT designer integrates the IT components in the calculation of the energy consumption.

The support of the cyber science for this Space green infrastructure could follow the scenario where the location of sustainable building is choosen thanks to climate data sets from satellites mixing the sensors to study the potential of a place. The social science as an add-on should determine the economic potential linked with the infrastructure.

This passive infrastructure applied to Space infrastructure shows the capacity to built it in a complex independent urban power grid. And as some design components are not compliant anymore due to the climat conditions, be sustainable become a factor for the survival of the equipements.

The model could be extended in others operational solution and location. For example, the sand is the third more important resource used after Water and the Air. And the sound of the sand as its humidity can be transformed in energy useful. The solution is re-taken by the waka tower principles, it means new forms of wells for people in the desert and beasts too. And the artificial technology would give the requirements of the sustainable economy by providing much acknowledge for the design of green Space infrastructure. This would avoid conflicts for the availability and the accessibility and should push the innovation for Space life on orbit.

2.1.2 The Safety Operating Center for the climate organization

The objectives of this geo-computation is the get the overview of the design a center to manage data flow in Space in the context of more dynamic flow due to the connectivity increasing on Earth orbit. The advantage of this approach is to provide a support for the climatic cyber-security in which the cyber science is applied to sustain the conditions for the life on the ground [5].

The key benefit of having a security operations center is the improvement of security incident detection through continuous monitoring and analysis of data activity. By analyzing this activity across an organization's networks, endpoints, servers, databases and critical infra around the clock. The 24/7 monitoring provided by a CSOC gives organizations an advantage to defend against incidents and intrusions, regardless of source, time of day, or attack type. The method is to add the safety approach at the security operations center described on the figure on below.

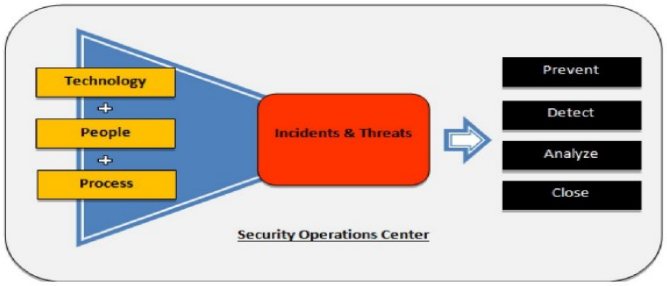

Figure 4 **: Security Operations Center Model**

The center means the capacity to operate data to ensure the operational capacity of the building. It includes the requirement of RAMs and Cyber framework. The organization model is based on the architecture of the building .

The specificity is the capacity to ensure the data monitoring and the data dissemination for the building status are linked with the status expected [6].

With the AI assistant, the health of the building can be followed thanks to the parameters :

- The data-sets of the building with the requirements of PHI

- The API to link the data-sets on duty with the values displayed

- The values displayed come from the sensors installed on the building

The gap between the values displayed and the one from the PHI requirements provides the inputs for the climatic cybersecurity. The model can be extended with the data coming in Space to check the status of the environment around the building. In the context of PHI, the safety ensures the functionalities of the building to the operational security through the technology, people and the process. And the HPC computing to support the health of the building works via green computing in which the energy requirements are linked with the PHI certification.

The geo-data including in the cyber science provides a methodology to build a sustainable system for the buildings in other conditions. It requires a computation approach and design in which the HPC computing combined with geo-data supports the conditions of the life in the building thanks to the energy management.

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