Care before business: on the potential of emergy analysis to address the sustainability of not-for-profit systems

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INTRODUCTION

Tools and methods to assess **sustainability** are often focused on lucrative activities, searching for behaviors that preserve some **business-as-usual** while at the same time taking into account environmental issues. Emergy analysis was originally inspired from and applied to natural ecosystems as an approach to **geobiophysically** account for **non-monetary** inputs. In recent years, however, even emergy accounting has been more and more applied to investigate the supply of products and services that are mostly referred to **budgeted** investments – be them public or private.

BACKGROUND

Primary services have been progressively invaded by market mechanisms, and their sustainability is often dwarfed by the urgency of the services they deliver. Also in **genuine not-for-profit systems**, the goodness of the objective tends to make their sustainability appear as something less important, yet the very dimensions of sustainability allow for the **capability of a system to last** over time; the better the output of a system, the more important its ability to keep functioning.

OBJECTIVES

- To understand the **systemic functioning** and the overall resources demand of systems not pursuing profit, compared to those pursuing it instead.
- To identify possible positive **feedbacks** able to maintain such systems.
- To assess the effectiveness of possible **sustainable solutions** to reduce the dependency of a system on nonrenewable resources.

MATERIALS AND METHODS

The main case study consists in a specialised hospital, the ***Salam* Centre for Cardiac Surgery**, built and run by Italian humanitarian NGO *Emergency Onlus* in Khartoum, **Sudan** – the only structure offering such cures free of charge in an area as big as three times the size of Europe and populated by over 300 millions people. Although the primary goal of the NGO is to grant the universal **right to health** (especially but not only in contexts affected by war and poverty), some wisdom was shown in the design of a top structure pursuing **sustainability** in exploiting local renewables to reduce the use of nonrenewable resources. Some results of this case study have been already collected in some scientific works (Cristiano, forthcoming; Cristiano *et al.*, 2017; Cristiano & Gonella, 2017).

An old Persian badgir (wind tower/tunnel)

The façade of the *Salam* Centre (above) a cardiological visit inside (left), and the solar thermal system (right).
(photos by Marcello Bonfanti; courtesy of *Emergency NGO*)

The Salam Centre for Cardiac Surgery

Built (2004 – 2007) in Khartoum, Sudan, close to Blue Nile river; design by *Emergency NGO* & *TAM associati*

Area (with gardens): 12,000 m² – indoor area: 40,000 m²

Free healthcare to patients from 20+ countries: average ly 700 operations and 7000+ visits a year

Temperatures:

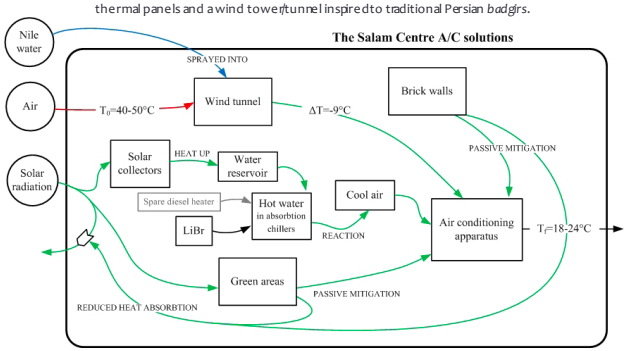
Outdoor average temperature: 45°C (113°F) – required temperature in operating theater: 20°C (104°F)

Strategies:

A) Passive mitigation solutions to reduce energy demand:

[58-cm (23") external walls, 2 layers of local clay bricks, with paneled insulated air chambers; Small double-glass windows to improve thermal insulation, protected by sunscreening films; Locally twined vegetal panels to screen porticos; Green areas to provide environmental mitigation]

B) Air conditioning systems based on local renewables (sun, wind, water), and including almost 300 solar thermal panels and a wind tower/tunnel inspired to traditional Persian *badgirs*.

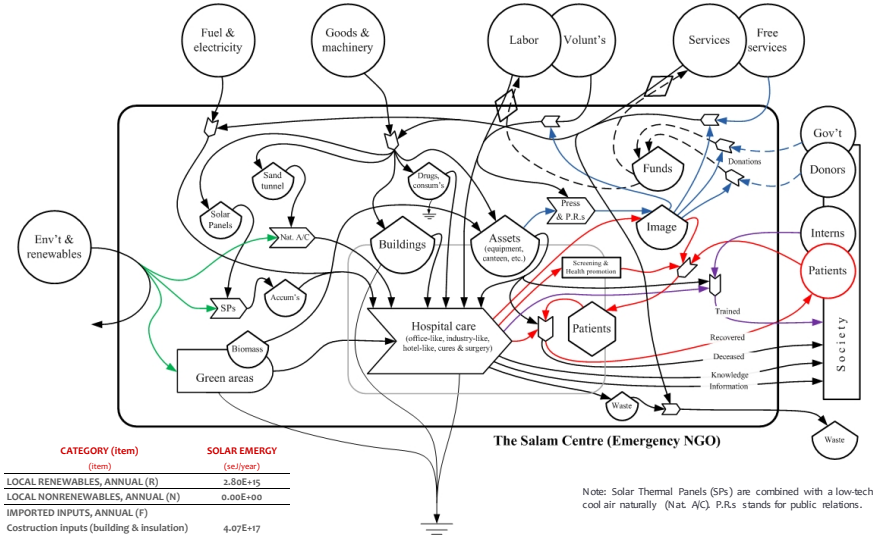


Logic scheme of passive and low-tech modern-vernacular hybrid air conditioning (A/C) solutions

Another case study is represented by a **dog shelter** in Padua, Italy, managed by an association of volunteers and to which an entire poster is dedicated at the 10th Emergy Research Conference (Gonella *et al.*, 2018) starting from the outcomes of a recently discussed B.Sc. thesis (Brocca, 2017). An additional case study on a **Pakistani public hospital** is currently being finalised too (Ali *et al.*, forthcoming). Other studies have been carried out within the same socially-concerned research stream involved **disarm and peace studies** (Gonella *et al.*, 2017).

Our case studies are first addressed qualitatively through the **systems thinking approach** (cf. e.g. Meadows, 2008), then also quantitatively by means of **Emergy synthesis** (cf. Odum, 1996; Brown & Ulgiati, 2016), mostly **integrated with Life Cycle Assessment** (Raugei *et al.*, 2014).

DIAGRAM, EMERGY CATEGORY FLOWS AND PERFORMANCE INDICATORS OF OUR MAIN CASE STUDY



Note: Solar Thermal Panels (SPs) are combined with a low-tech sand-/wind-tunnel to cool air naturally (Nat. A/C). P.R.s stands for public relations.

CATEGORY (item) (item)	SOLAR EMERGY (sej/year)
LOCAL RENEWABLES, ANNUAL (R)	2.80E+15
LOCAL NONRENEWABLES, ANNUAL (N)	0.00E+00
IMPORTED INPUTS, ANNUAL (F)	
Costruction inputs (building & insulation)	4.07E+17
Solar thermal & air conditioning systems	2.67E+16
Biomedical equipment	2.97E+16
Furniture	8.77E+14
Technical equipment	2.26E+15
Vehicle fleet	8.61E+15
Fuel and electricity	1.06E+18
Goods	7.86E+17
Transportation inputs for imported items	3.91E+16
Labor and services	5.92E+18
TOTAL EMERGY (U)	2.36E+18
TOTAL EMERGY (ULS)	8.28E+18

Conventional performance indicator	Value w/out L&S	Value w/L&S	Unit
Emergy Yield Ratio (EYR)	1.001	1.000	-
Environmental Loading Ratio (ELR)	856	2969	-
Emergy Sustainability Index (ESI)	0.001	0.000	-
Emergy Investment Ratio (EIR)	856	2969	-
Percentage Renewable Emergy (%Ren)	0.12%	0.03%	-
Areal Empower Intensity (AER), indoor	1.92E+14	6.66E+14	sej/m²
Areal Empower Intensity (AER), land parcel	6.00E+13	2.08E+14	sej/m²
New emergy indicators	**Value w/out L&S**	**Value w/L&S**	**Unit**
Hospital annual operating emergy demand	2.40E+18	8.32E+18	sej/yr
Emergy per cardiac surgical operation	4.35E+15	1.51E+16	sej/operation
Emergy per patient-day	1.49E+14	5.17E+14	sej/patient-day
Emergy per outpatient visit (triaged patient)	4.18E+14	1.45E+15	sej/visit

KEY LEARNINGS

- Not-for-profit systems can be very **sophisticated** and emergy demanding. **Unpaid** activities still require **resources and favorable socio-economic conditions**. In light of their valuable outputs, a debate is to be started on societal priorities and savings elsewhere, in order to act systemically to protect such systems (and, with them, human rights e.g. health) from the fluctuations of a neverending environmental and financial crisis, or think beyond it.
- Not-for-profit systems often rely on **reinforcing** feedbacks, mainly basing on **image** and reputation to **raise funds** and donations, attract **volunteers**, and successfully yield their activities of social interest.
- In the case study of the ***Salam* Centre**, a positive environmental and monetary benefit is reached through the adoption of **low-tech solutions** in energy systems and building technologies. Although their impact does not significantly affect the overall emergy requirements of the system due to its complex functioning, such solutions can be **exported to building design** to foster a genuine and **systemic sustainability**.

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