Healthcare facilities in disaster and rescue zones; Characteristics and future directions

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TECHNION
Israel Institute of Technology


Hurricane Matthew

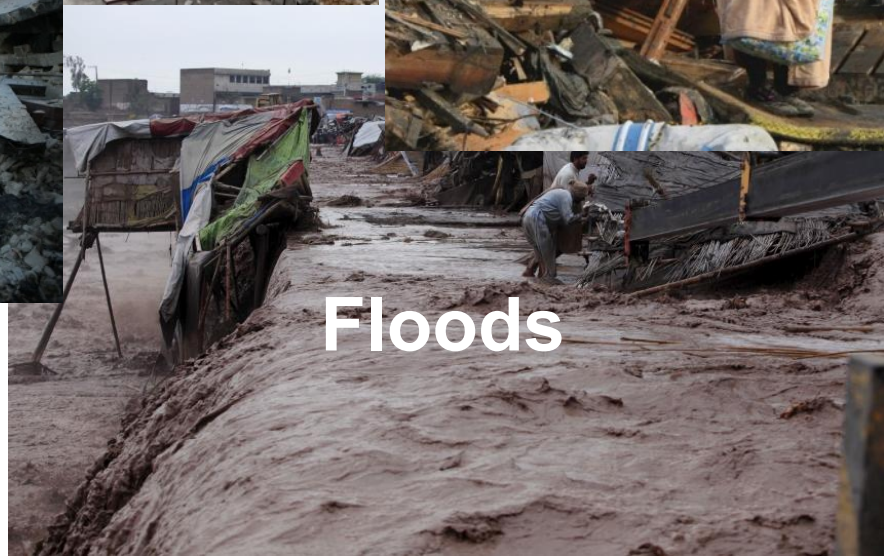

Earthquake


Tornado


Earthquake


Earthquake


Tsunami


Floods


Hurricane Matthew
Cuba


Earthquake
Italy


Tornado
Oklahoma


Earthquake
Japan


Haiti
Hurricane


Tsunami
Indonesia


Floods
Pakistan

Natural Disaster

A **sudden** and **terrible** event in nature that usually **results** in serious **damage** and many **deaths** (Merriam-Webster).

The **severity** of a disaster is measured in:

- **Loss of life**
- **Damage to structures**
- **Economic loss**
- **Ability of the population to rebuild (**mental and/or physical)**.**

2 dimensions: Scale and Outcome

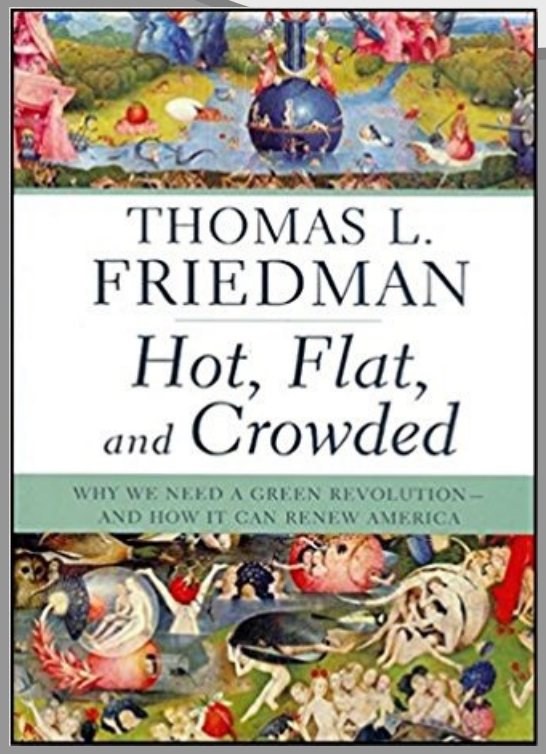
(Norris *et al.* 2002).

Natural disasters

number and intensity

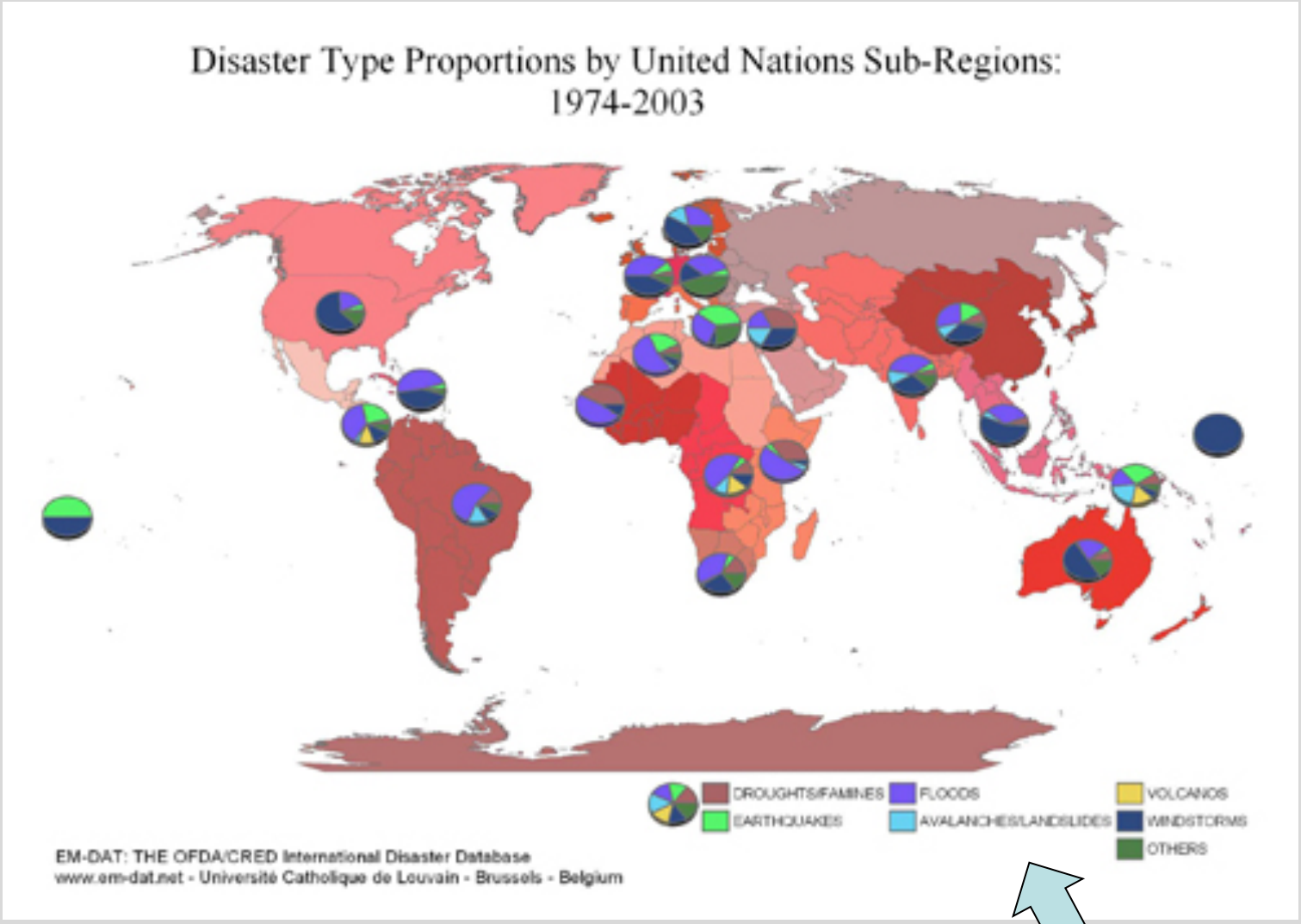
Global warming

Population explosion



Spread travel

Overcrowding of cities



http://www.emdat.be/world-maps

Natural disasters

Tsunami

Earthquake

Hurricane

Glacier avalanche / snowslip

Tornadoes

Epidemic SARS, Ebola

Floods

Droughts

Cold wave, Heat wave

Man-made disasters

Terror Attacks
Chemical Plant Explosions
Wars
Explosions,
Chemical spills,
Accidents
Nuclear Power Plant Explosion

FAST RESPONSE !!!

FAST RESPONSE !!!

Food & water
Supplies
Shelter
Technical assist

UNISDR
The United Nations Office for Disaster Risk Reduction

The united nations office for disaster risk reduction

OCHA
ABOUT US | WHAT WE DO

united nations office for coordination of humanitarian affairs

MEDICAL SUPPORT HOSPITALS

Centre for Research on the Epidemiology of Disasters CRED
Home | About | Projects | Staff | Publications

Centre for the research on the epidemiology of diseases

EM-DAT
The International Disaster Database
Centre for Research on the Epidemiology of Disasters - CRED

The international disaster database

UNHCR
The UN Refugee Agency

The United nations High Commissioner for Refugees

military, national rescue, ,IGOs, NGOs, private delegations…….

Methods

literature, websites reports, newspaper articles, movies , videos

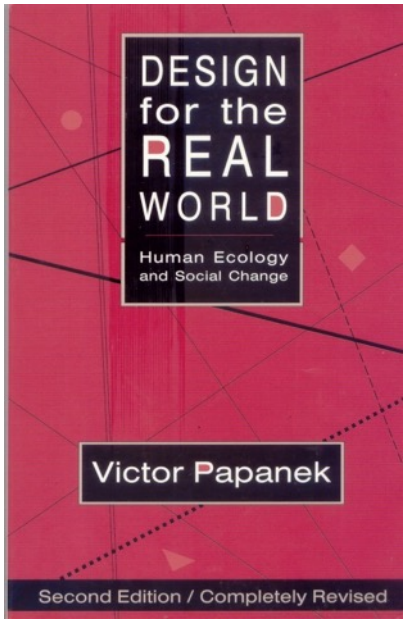
field hospital, mobile facilities, deployable, transient, transportable, temporary, flying h, airborne h, floating h, portable architecture, movable h;

alone and in combination with disaster, rescue, salvage,

Name	Use		Ownership			Materials						Terrain				Permanency		Transport						Disaster Type			Weather		
	M	S	M	C	N	M	PL	R	F	W	PA	F	S	W	C	Perm	Temp	ST	PL	SH	V	H	PA	E	W	F	C	H	S
USNSC	x		x			x	x							x		x		x		X				x	x	x	x	x	x
SU		x		x		x	x					x	X		X		x		x	x	x	x		x	X			x	
CIAC	x			x	X	x	x					x			X	X				x	x			X	x		x	x	
DWB	x				x			x	X			x			X		x		X	x	x	x	X?	x	x				
HCM	x			x		x	x					x			X	x		x						x	x		x	x	X
KH	x			x		x						x			x		x		x	x				x	x		x	x	x
~~QS72~~	~~x~~	~~x~~		~~x~~			~~x~~					~~x~~			~~x~~		~~x~~				~~x~~			~~x~~	~~x~~		~~X~~	~~x~~	
MA	x		x			x	x								x	x		x							x		x	x	x
IDF (9)	x		x			X			x			x			x		x		x	X	x		X	x	x		x	x	x
MS	x			x		x						x			x		x			x	x			x	X	x	x	x	x
MF	x	x		x		x		x				x			x		x				x			x	x		x	x	x
MT	x			x			x					x			x		x					x		x	x			x	
MMMF	x				x	x	x					x				x		x							x	x		x	x	x
EC145	x			x		x	x					x			x	x		x							x	x	x	x	x	
RFHT	x		x				x					x			x		x				x			x	x		x	x	x
WS		x		x					x			x	x	x	x		x						x			x	x		
PLH		x		x			x			x	x	x					x				x		x	x	x			x	
ERS		x			x	x				x		x	x			x					x			x				x	
FHMMU	x			x		x	x					x	x			x		x						x	x		x	x	x
LB		x		x			x				x	x		x	x		x		x		x		x	x	x	x		x	
ERH		x			x					x		x					x							x	x			x	
RC		x		x			x					x	x		x		x				x			x	x			x	
EVO	x			x					x			x			x		x		x		x			x	x		x	x	x
AMB	x		x	x	x	x	x					x	x		x	x		x						x	x		x	x	x

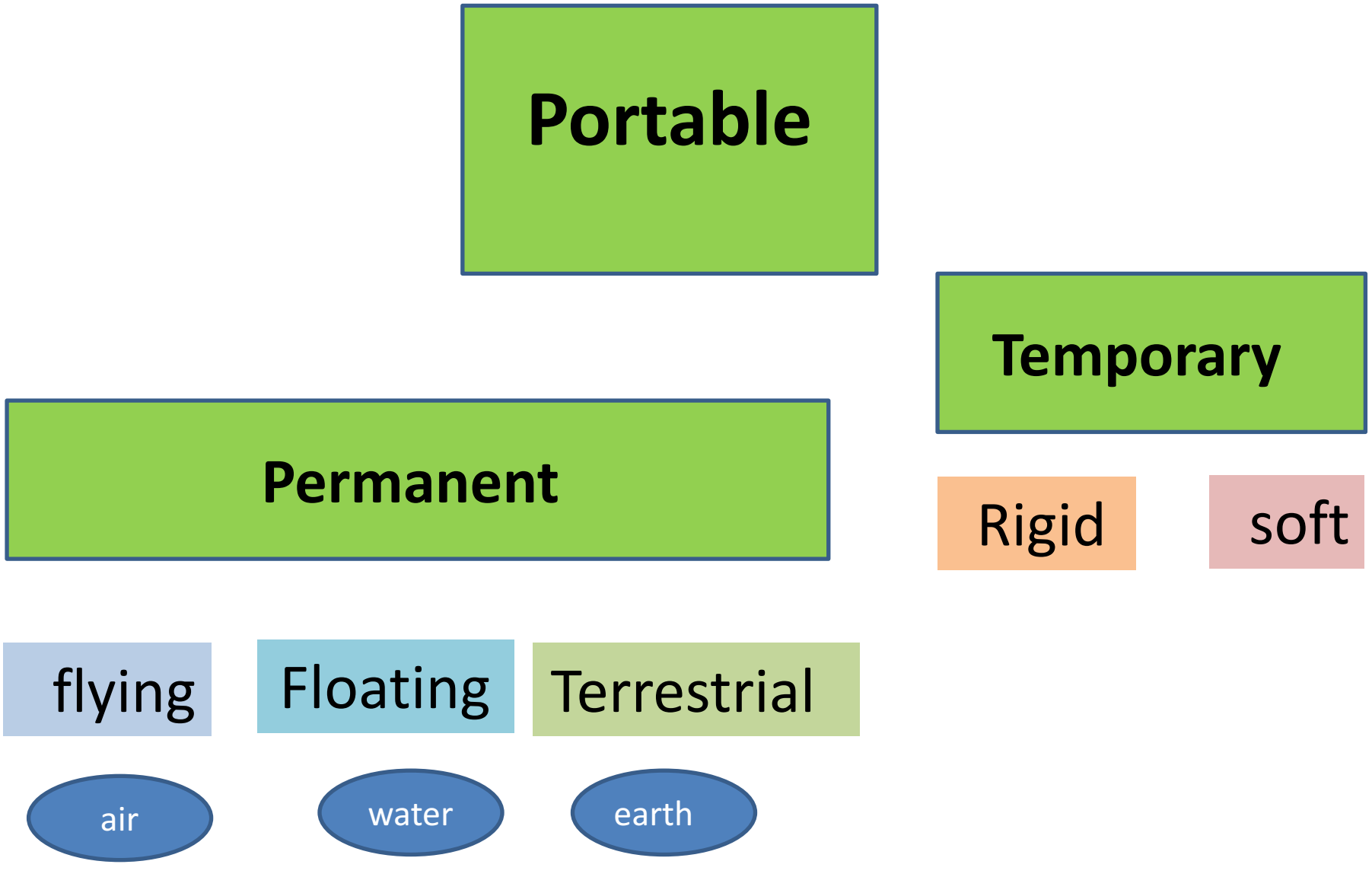
Aims

- **Characterize** configurations & structures of current healthcare facilities at rescue and salvage zones,
- **Evaluate** strengths and weaknesses,
- Suggest **future directions**.



Encourage architects & designers to join up

Healthcare Facilities at Disaster Zones



Floating hospitals

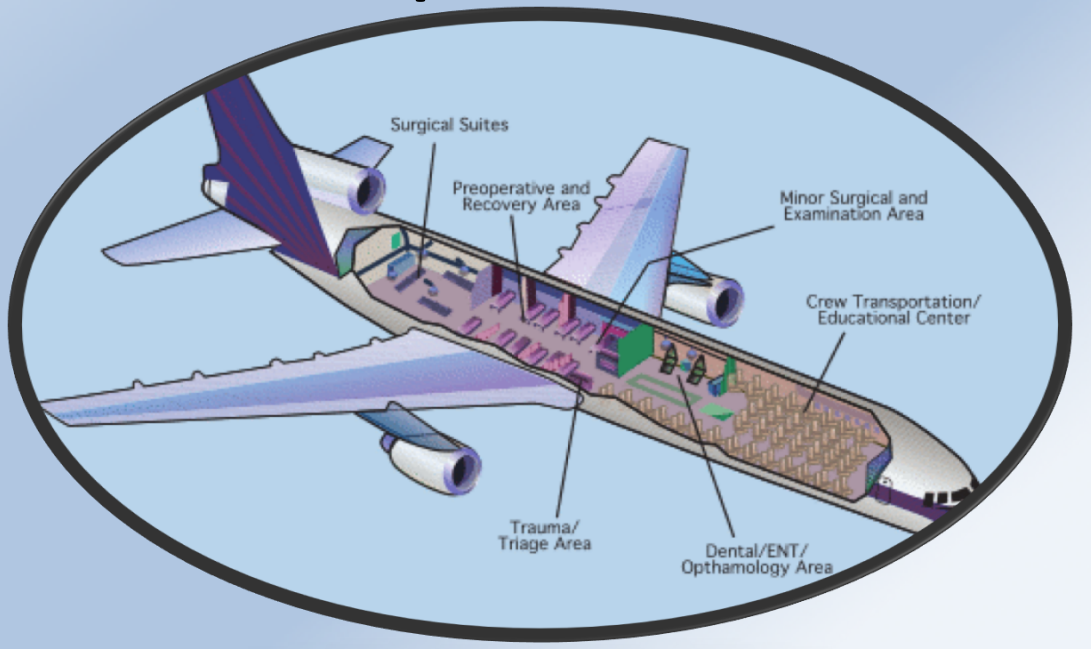
USNS Comfort (USNSC)

Russian

Chinese hospital ship (Peace Ark)

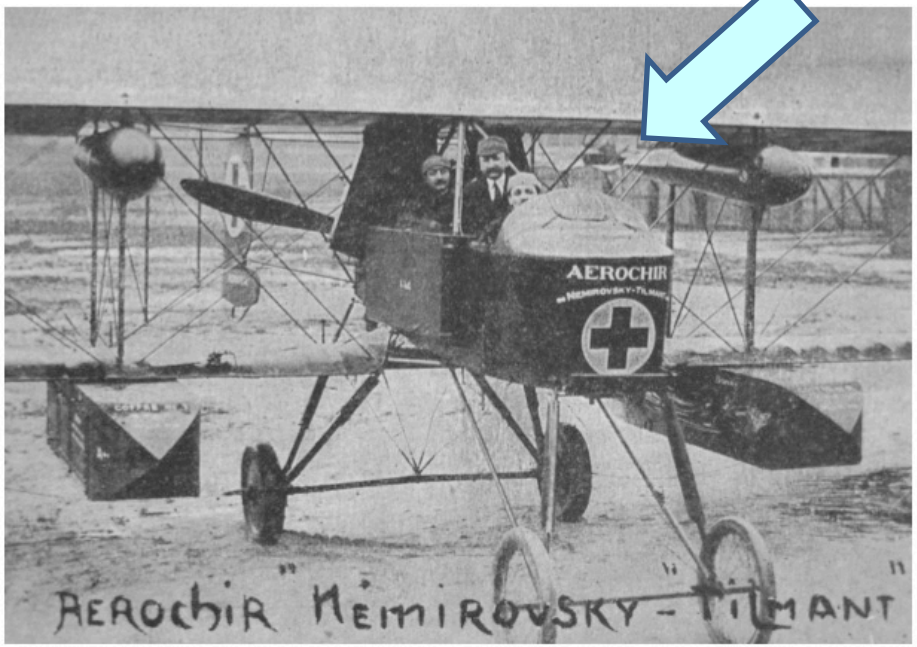
German

Airborne hospitals



http://www.mercyairlift.org/flyinghospital/airplane.html1

The Aerochir: The First “Flying Hospital”



Nemirovsky-Tilmant Aerochir 1919
served as a proof-of-concept product

ıstration of urgent surgical intervention with materiel carried by … center, without hat, Dr. Foveau de Co… or Stepensky. The power supply for the X-ray, the wash basin, the su… and the sterilizer are well-depicted … surgeons" are not wearing gloves or gowns, which were to be carried … Aerochir.

inflatable tent

Mobile earth-bound healthcare facilities

Hurricane Katrina.

Permanent portable healthcare facilities

- Self-contained and self-transportable,
- Continuously active and fully functioning facilities,
- Short time for full function
- Fast evacuation

Permanent portable healthcare facilities

- Self-contained and self-transportable,
- Continuously active and fully functioning facilities,
- Short time for full function
- Fast evacuation
- **Contain complete medical equipment**
- **Infrastructure (power, communication, water, oxygen, medications, and medical supplies**
- **Operated by professional personnel,**
- **Housing and services for staff**

Weakness

- **Self-transportable (speed, medium)**
- Final destination ≠ disaster zone
- Closed systems; no modularity, inflexible
- Limited space, no enlargement

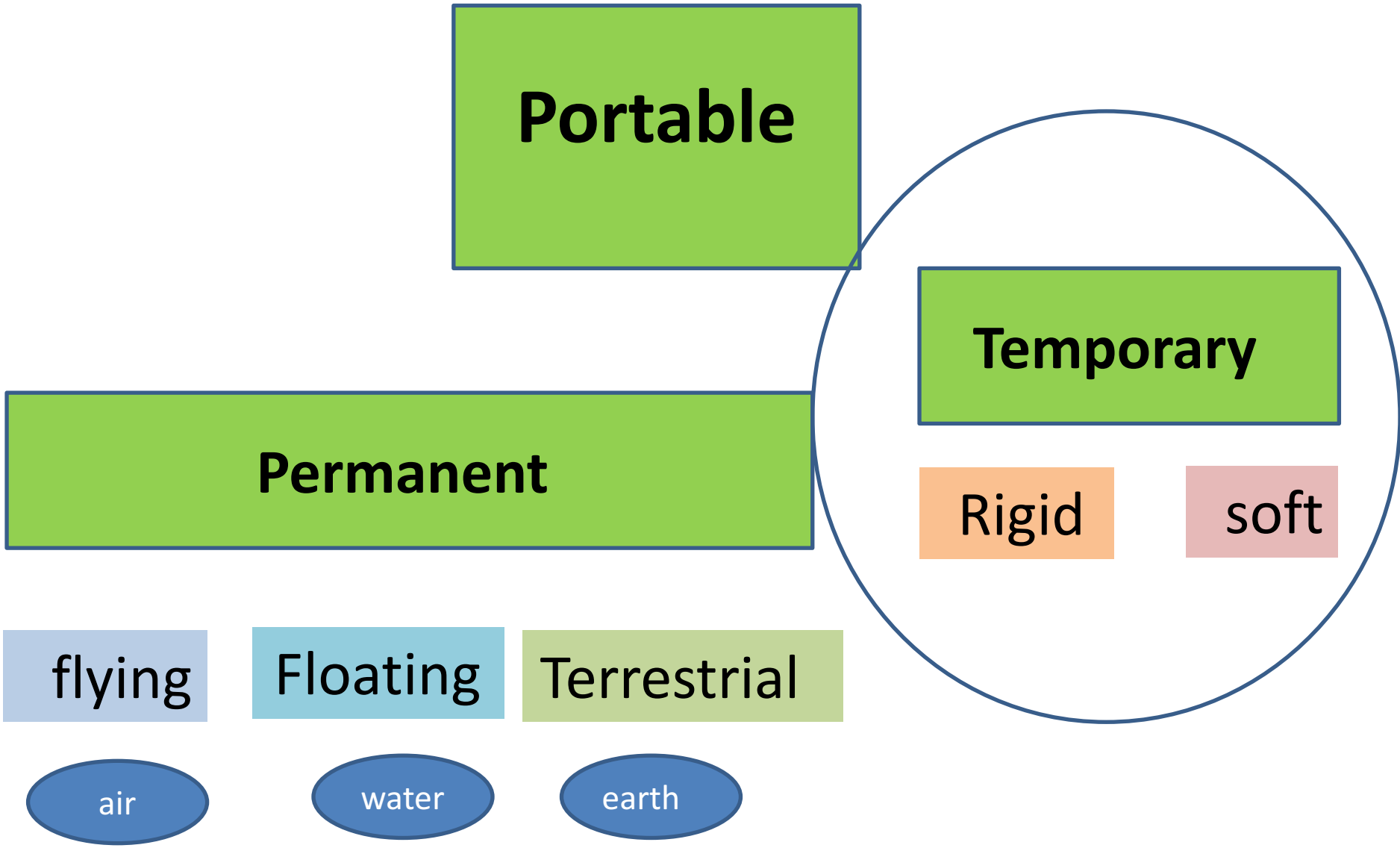
Inaccessible, restricted movement (staff ,wounded , stretcher)

- No option for shelter or humanitarian housing
- Suitable for Short term missions
- Not a hospital (transportable **envelope** of an hospital)

Matvei Mudrov Medical Facility, Russia

150 patients/day
15 days trip

Healthcare Facilities at Disaster Zones



Temporary Soft Healthcare Facilities

IDF

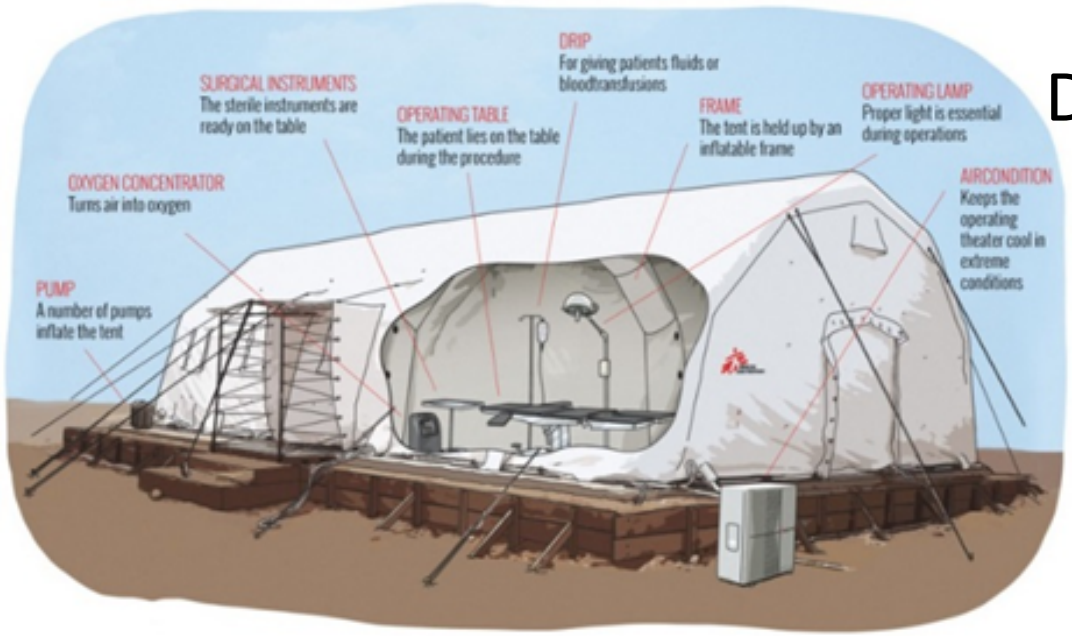
Tent

triangle, round, polygon

Russia (-50)-(+50)oC

UN Ranks Israel's Field Hospital as Best in the World, 2016

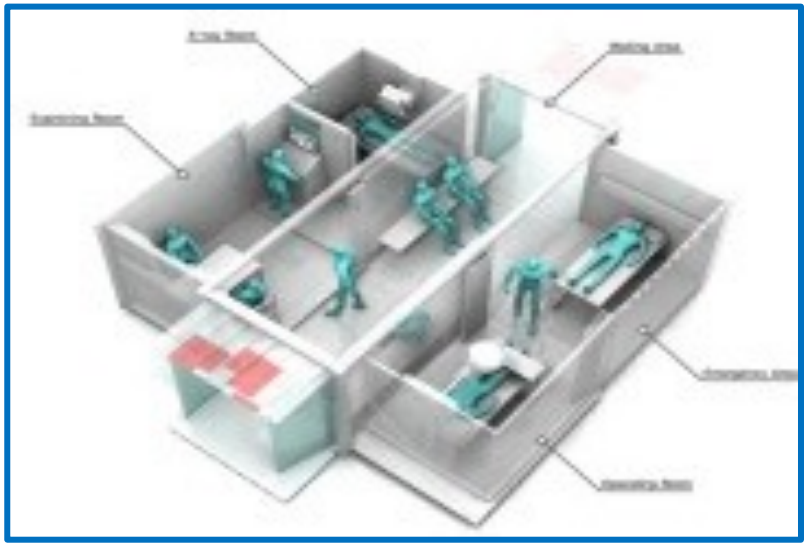
Field Operating Rooms



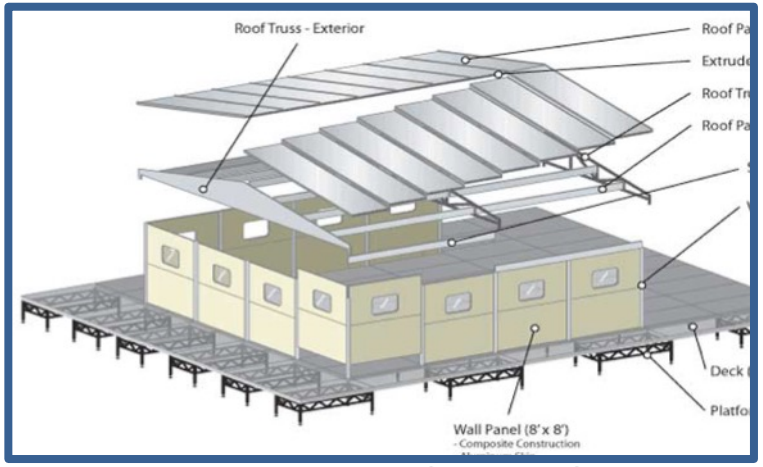
Doctors Without Borders

OR+ clean rooms

Rigid Temporary Healthcare Facilities



A cubic container that can be expanded



A structure erected from flat elements

Cubic rectangular right-angled morphology

A foldable structure

Temporary Healthcare Facilities

- Light & small volume (foldable, collapsible, flat), assembled on-site ➔camp.
- Modular, flexible, accommodates needs
- Cheap, low tech
- Can be left on site for use by local people
- can use any transportation (parachute)
- can reach any place
- Can use local materials and local work
- Can use innovative materials, smart, solar panels…

Weakness

- **Takes time** to build and disassemble
- Furniture, power, water, sanitation, gases installed separately
- Designated transportation
- Construction of a floor and platform
- Connection between the single units
- Storage between missions,
- No permanent staff (volunteers)

Most of healthcare facilities at disaster zones **have not been designed** by **architects and engineers**

to

function specifically as **healthcare facilities**.

Compatible with

Aviation, deck work, vehicle industry

Military, camping, commercial and excursion expeditions

Specifications

- ✓ Dynamic, changeable, adaptable, modular
- ✓ 'Smart' responsive
- ✓ Minimal and smart transportation
- ✓ Short time for start of work
- ✓ Reduce installation time and resources
- ✓ Sustainable smart energy supply
- ✓ Cost effective- not disposable
- ✓ Long term use
- ✓ Healthcare oriented (emergency, phase, casualties, culture)

Future directions

On site building

3D building

autonomic systems

(Robots)

Portable architecture

Airtecture

Innovative technology

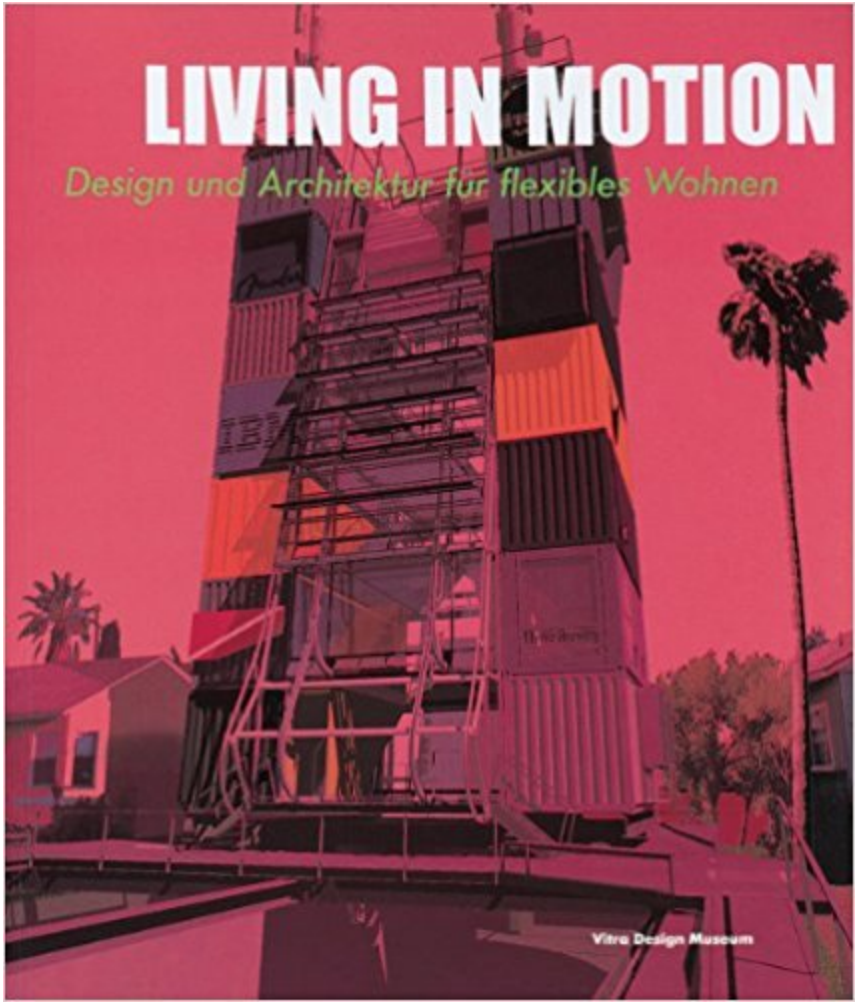
smart technology

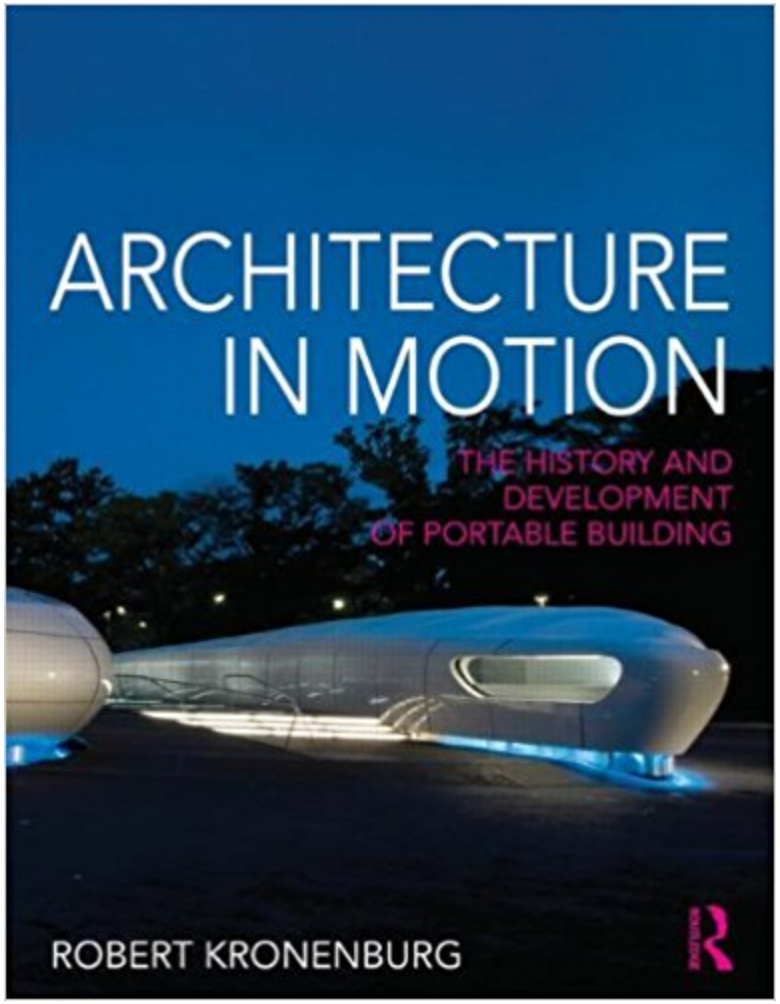
Smart materials

Tele/virtual reality

Integrated transportation

Portable architecture -
Flexibility, mobility and versatility



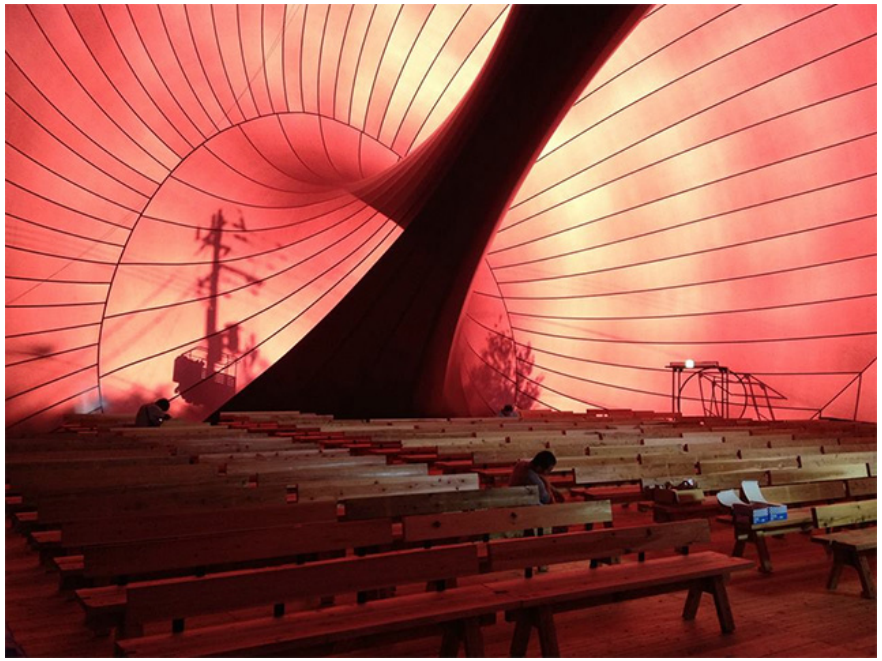


Air-inflated fabric structures

Airtecture, Pneumatic Structure, Pop Up housing

- Air available everywhere, universal,
- Sustainable,
- Natural,
- Cheap,
- The best temperature isolator,
- Light,
- Easy in shipping,
- Options for modularity by partial inflating,

Ark Nova: World's First Inflatable Concert Hall Will Tour Recovering Areas in Japan



Concert hall
Exhibitions
Sports
Events

3D printing houses

Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 151 (2016) 292 – 299

Procedia Engineering

www.elsevier.com/locate/procedia

International Conference on Ecology and new Building materials and products, ICEBMP 2016

3D printing of buildings and building components as the future of sustainable construction?

Izabela Hager*, Anna Golonka, Roman Putanowicz

Cracow University of Technology, Warszawska Str. 24, 31-155 Cracow, Poland

a) First house printed by a WinSun company in 2014; (b) Five-storey building printed in 3D

Novel 3 dimension (3D) technologies

Contents lists available at ScienceDirect

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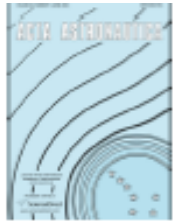

Building components for an outpost on the Lunar soil by means of a novel 3D printing technology

Giovanni Cesaretti[a], Enrico Dini[b], Xavier De Kestelier[c], Valentina Colla[d,*], Laurent Pambaguian[e]

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[c] Foster+Partners, Riverside, 22 Hester Road, SW11 4AN, London, UK
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[e] ESA European Space Research and Technology Centre, Postbus 299, 2200 AG Noordwijk, The Netherlands

Robotics (autonomous systems)

Innovative technologies

smart technology,

embedded sensors

Smart materials-

aircraft grade aluminum, plated steel, fiberglass

composed materials ,solar panels ,

Tele\virtual reality

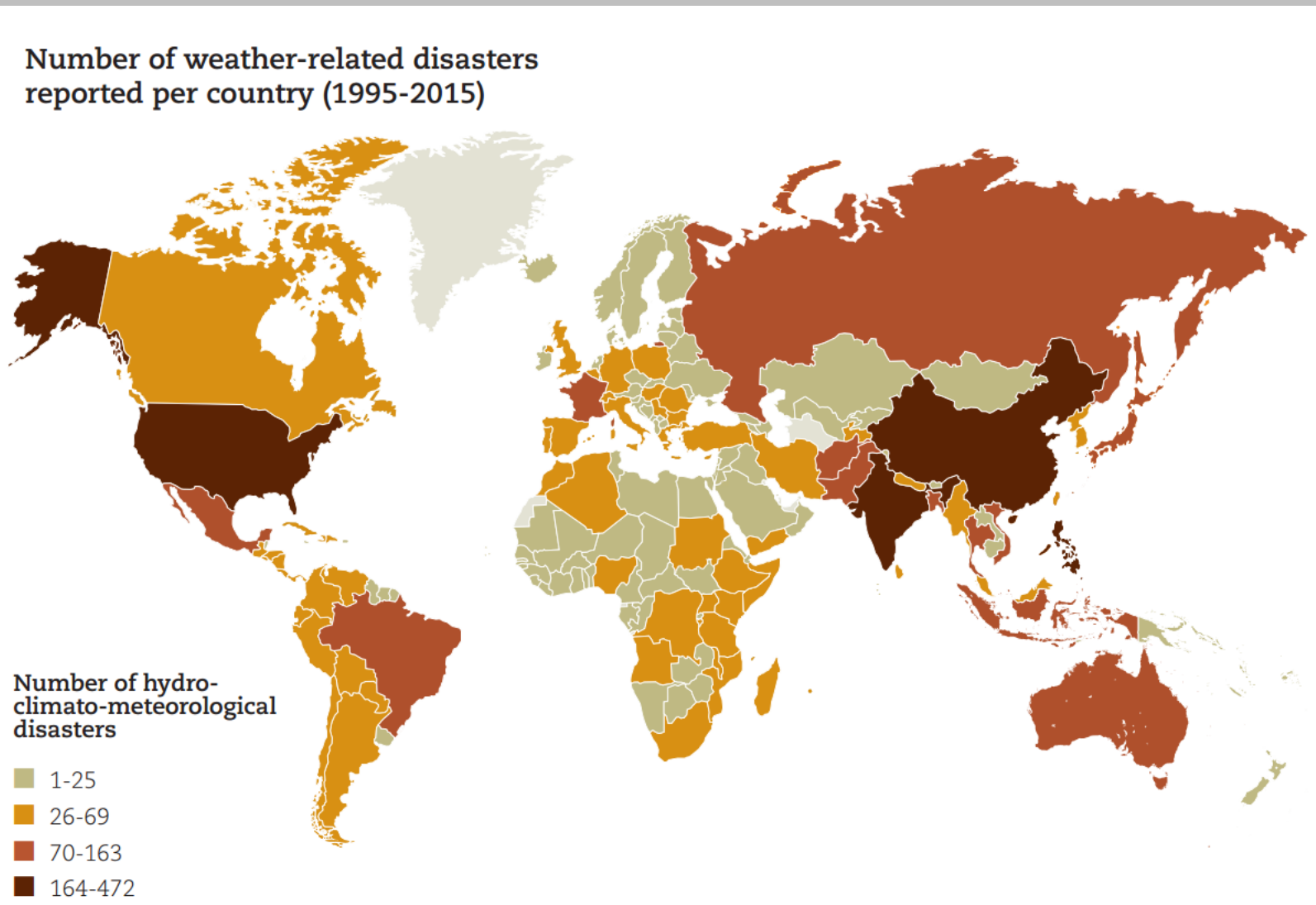
And more…

Designing healthcare facilities for disaster zones is a multidisciplinary challenge :

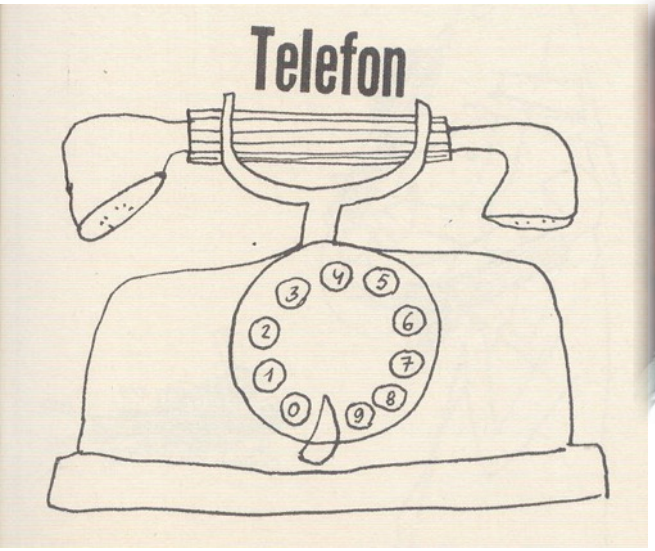
Researchers, scientists, and professionals:

architecture, design, material engineering, emergency & military medicine, surgery, search and rescue (SAR), and humanitarian organizations.

An opportunity for innovative rethinking and redesigning of healthcare facilities, applying advanced and innovative methods and concepts.



A picture is worth a thousand words……



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Unemployed.....

But better be prepared

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Studio Design for healthcare and human needs in disaster and rescue and in extreme environments