The Nubian Vault Programme
A cross-cutting development initiative in the Sahel

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www.lavoutenubienne.org
The Housing Challenge in the Sahel

> Deforestation, climate change, population growth
> Traditional timber / straw roofs no longer possible
> Millions of families living in precarious unhealthy tin-roof shacks
> High cash cost of imported roofing sheets, timber, cement..

Urgent need for an alternative adapted architectural solution...
...addressing housing, economic and rural development, and climate change adaptation and mitigation
I THE NUBIAN VAULT TECHNIQUE
Mud brick vaults in the Ramesseum, the temple of Ramses II, Luxor, built around 1250 BCE
AVN’s standardised Nubian Vault (NV)

Nubian vault - lateral cross-section

- Buttress filled with earth
- Plastic waterproof sheeting
- Small high quality mud bricks
- Ordinary mud or laterite bricks
- Final rendering of mud or cement
- Foundations of rocks and earth mortar
Nubian vault - vertical cross-section

- Plastic waterproof sheeting
- Surface rendering: mixture of mud and mineral and plant extracts
- 1 m - 1.70 m: 5 or 6 rows of bricks
- 1.30 - 2 m: 7 to 11 rows of bricks
- Standard mud bricks and mud mortar
- Foundations of rocks and earth mortar (of variable depth depending on the ground)
- + or - 0.50 m

Dimensions:
- 0.60 m
- 3.20 m
- 0.60 m
Twin-vault village house under construction, Burkina Faso
No timber shuttering or form-work needed
Vault radius defined by cord slider on guide cable
Use of the guide cable & cord to define the vault radius
Reinforced concrete post & beam for church, Burkina Faso
Cement render over ‘stony’ mud bricks, urban house, Senegal
II THE AVN PROGRAMME
The Nubian Vault Association (AVN)

> Founded in 2000 by Thomas Granier, French mason, & Seri Youlou, Burkinabe farmer
> Inspired by Hassan Fathy (Architecture for the Poor)
> Earliest constructions in Boromo, Burkina Faso
> 20% average annual growth rate over last 10 years
> 60 full-time staff in 2021
> Annual budget of 2.4 M € in 2021

NV buildings in Boromo, Burkina Faso
Seri Youlou & Thomas Granier in Boromo
Deployed in 5 countries & 13 regional and national centres with 50 local employees
Results as of July, 2021

53,000 beneficiaries living in or using a NV building

5,180 construction projects completed (=145,200 m²)

1,150 active NV apprentices, masons, artisans and entrepreneurs

1,500 localities with at least 1 NV

136,000 tonnes of CO₂ eq potentially economised

4.9 million euros generated in local circuits
III  NUBIAN VAULT BUILDINGS
A Nubian Vault building is...

> durable (solid, weatherproof...)
> comfortable (thermal mass, sound proof..)
> eco-sustainable, low carbon footprint
> affordable (self-build, mutual aid...)
> uses locally sourced labour & materials
> easily replicable, standardised
> roof terrace & upper storey possible
> modular, later extensions possible
Single vault village house, Mali - 86% of NV buildings are houses for rural families, AVN’s key target group
Traditionally decorated single vault house, Benin
Two-vault village house with roof terrace, Burkina Faso
Two-storey village house with roof terraces, Burkina Faso
Interiors of NV village houses, Burkina Faso
Merchant's house, Mali
NV poultry shed, Ghana - 9% of NV buildings are for agricultural use - storage of crops, livestock ....
Onion storage barn, Mali
Community Centre, Senegal
- 5% of NV buildings are for community use (health centres, literacy centres, schools, mosques..).
NV school building, Kati, Mali
Single vault school classroom, Kodeni, Burkina Faso
3 vault classroom, concrete post & beam, Djindjinebougou, Mali
Health centre, Taif Tiekene, Senegal
Church in Petit Balé, Burkina Faso
Sheikh Zayed Village for refugees, Diakré, Mauritania
(51 NV houses, maternity clinic, mosque & school)
Diakré village house and owner
Thermal comfort data

Daily temperature profile, Ngueye Gueye, Senegal, 13/03/2015

- **EXTerior**
- **Iron-sheet roofs**
- **NUBIAN VAULT**
IV AVN’s DEVELOPMENT STRATEGY
AVN’s Development Strategy

Three transversal themes

Habitat (housing, community, agriculture...)

Economic & Rural Development

Climate Change Mitigation & Adaptation
Three Complementary Axes

A ROOF
Involve stakeholders in the diffusion of the NV concept

A SKILL
Strengthen the skills of the NV trades sector

A MARKET
Stimulate the demand for NV construction

Reminder - AVN neither builds nor sells houses:

« Rather than giving people fish, teach them to fish for themselves, to make their nets and sell the fish »
A Roof

The goal: to create & accelerate the demand for adapted bioclimatic construction

> AVN regional offices in small towns
> awareness raising
> pilot villages & credible ‘champions’
> local stakeholders
> demonstration buildings
> formal recognition / standards compliance
AVN Regional Office, Koutiala, Mali
AVN Regional Office, Garu, Ghana
Village awareness-raising meeting, Burkina Faso
A Skill

The goal: to provide a continuing supply of skilled masons to meet the growing demand

> role of AVN regional centres
> cascading of recruitment
> training & construction during the dry, fallow, season
  > dual on-site and classroom training
  > network of trainer masons (currently 54)
> progression from apprentice to entrepreneur
  > formal recognition of competence
> inclusion in Professional Training Centre curricula
77 NV masons from Burkina Faso receive formal certificates of competence (August 2021)
NV entrepreneur’s premises, Samandeni, Burkina Faso
The goal: to accelerate the growth of the emerging NV market

> advocacy & fund-raising by AVN-International
> transfer to local operational partners (29 in 2021)
  > role of AVN regional centres
> ‘adapted housing’ micro-finance products
> cash incentive schemes for rural clients,
> climate adaptation & attenuation funds (climate justice)
> trading of NV carbon credits / offsetting
Construction Incentive Coupons (CIC) & NV Carbon Credits (NV-CC)

> financial incentive to client for 25 m2 NV house of 270€ ( = 15 - 20 % of total construction value & 80 % of cash payment)
  > + 100 € distribution, monitoring & capitalisation costs

> a NV house of 25 m2 generating a reduction of 20 t eq CO₂ & a total incentive cost of 370 € >> cost of 18,5 € / t eq CO₂

> income from NV-CC’s finances the CIC’s

> verification: online cartographic registry of NV-CC’s

601 NV houses built in 2020/21 season with CIC’s
POTENTIAL CO₂ SAVINGS

tons of CO₂ eq over 30 years for a 25sq. meters building

- CO₂ EMISSIONS FOR BLOCKWORK WALLS + CONCRETE SLAB: 26.1 t (80%)
- CO₂ EMISSIONS FOR NUBIAN VAULT: 5.6 t (66%)
- POTENTIAL CO₂ SAVINGS: 20.5 t (83%)

Legend:
- Green: Air-conditioning
- Orange: Materials + Maintenance
CIC dynamic mapping
Example of CIC data

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![Map of the area with marked locations.](image-url)
More buildings built → NV Masons trained → Demonstration sites → More NV entrepreneurs → More NV masons trained → Virtuous Circle of the Nubian Vault Market
Evolution of the methodology

1998 - 2000
R&D and conceptualisation of the NV technique
- Standardise a locally transmissible adapted technique

2000 - 2014
Kickstart a NV market
- Kickstart the market and demonstrate the validity of the solution and its market potential
- Diffusion methodology

2014 - 2018
Densification of the NV market
- Involve the construction sector, develop NV professional training and increase the demand
- Training methodology

2018 - 2030
Skills transfer and capacity building of partners
- Mobilise and accompany local actors to implement the NV concept in their own intervention territories
- Transfer methodology
V CONCLUSION & SUMMARY
A cross-cutting Development Strategy

- habitat (housing, community, agriculture...)
- economic & rural development
- climate change mitigation & adaptation

AVN’s Actions for the Sustainable Development Goals

1. No Poverty
2. Decent Work and Economic Growth
3. Industry, Innovation, and Infrastructure
4. Quality Education
5. Reduced Inequalities
6. Sustainable Cities and Communities
7. Responsible Consumption and Production
8. Climate Action
9. Life on Land
Habitat

Nubian Vault construction used for
> rural & urban housing
> community buildings, schools & health centres
  > agricultural buildings
  > offices, workshops
> emergency housing / refugees

Renewal of a Sahelian “Archi-culture”
> locally sourced materials
  > labour intensive
  > roof terraces
> evolution of traditional skills

5,180 NV buildings completed
53,000 beneficiaries living in / using NV buildings
Economic & Rural Development

> reduction in use of costly imported construction materials
  > local economic circuits strengthened
    > development of a new ‘green’ construction sector
      > professional training & job creation
    > reduction in rural exodus / population stabilisation
  > improved health conditions (homes, schools, clinics...)
    > improved agricultural storage conditions

1,150 active NV apprentices, masons, artisans & entrepreneurs

4.9 million euros generated in local circuits
Climate Change
Adaptation & Mitigation

> adapted bioclimatic habitat sector & green jobs
> comfortable, resistant & durable buildings
> use of climate funds (Green Fund, Adaptation Fund...)

> reduced use of high carbon footprint construction materials
> use of local materials (earth, rocks, water...)
> passive thermal performance of NV buildings
> low carbon impact over NV lifetime / reduced energy demand
> protection of timber and straw resources

136,000 tonnes of $\text{CO}_2_{\text{eq}}$ potentially economised