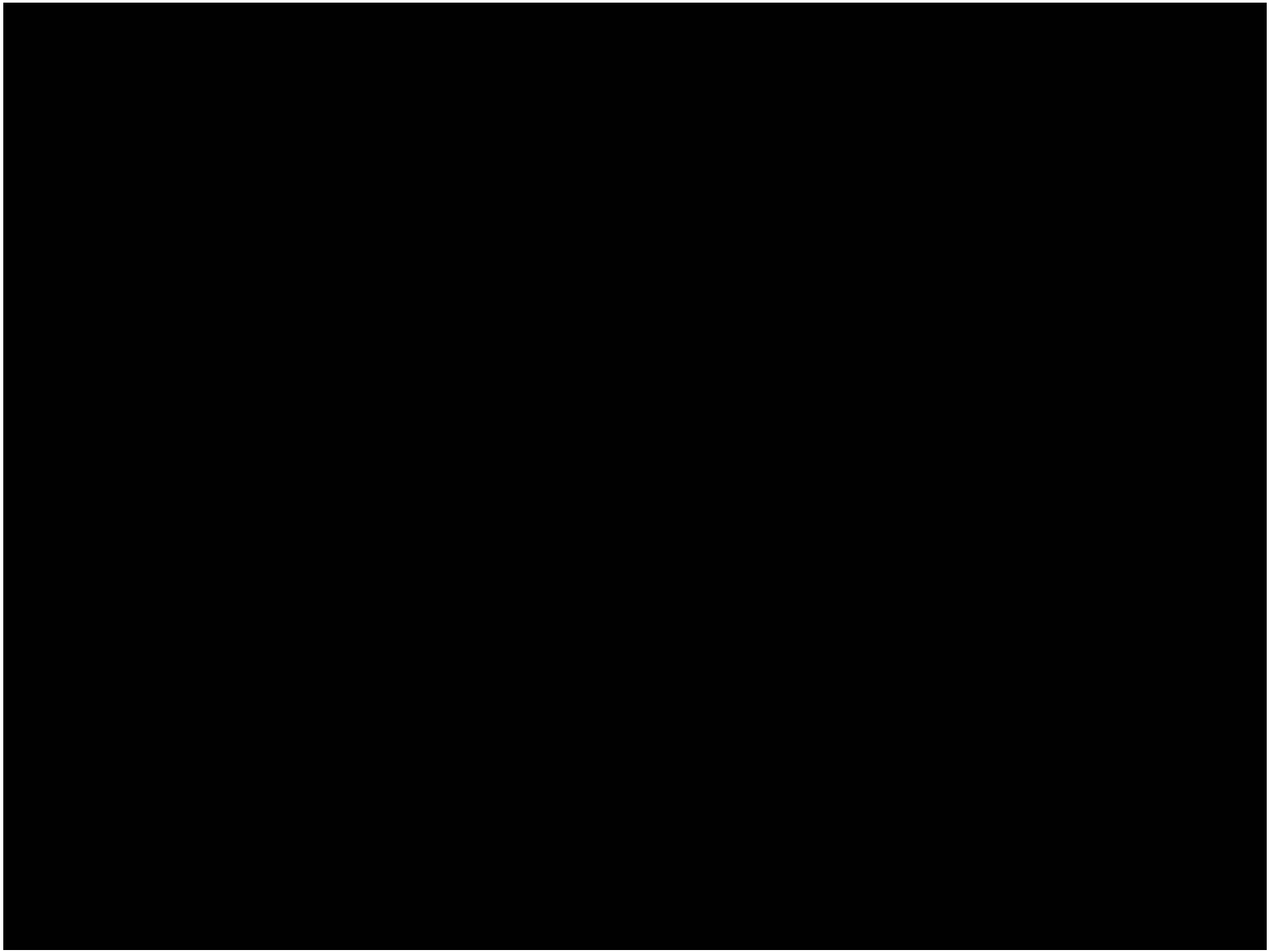
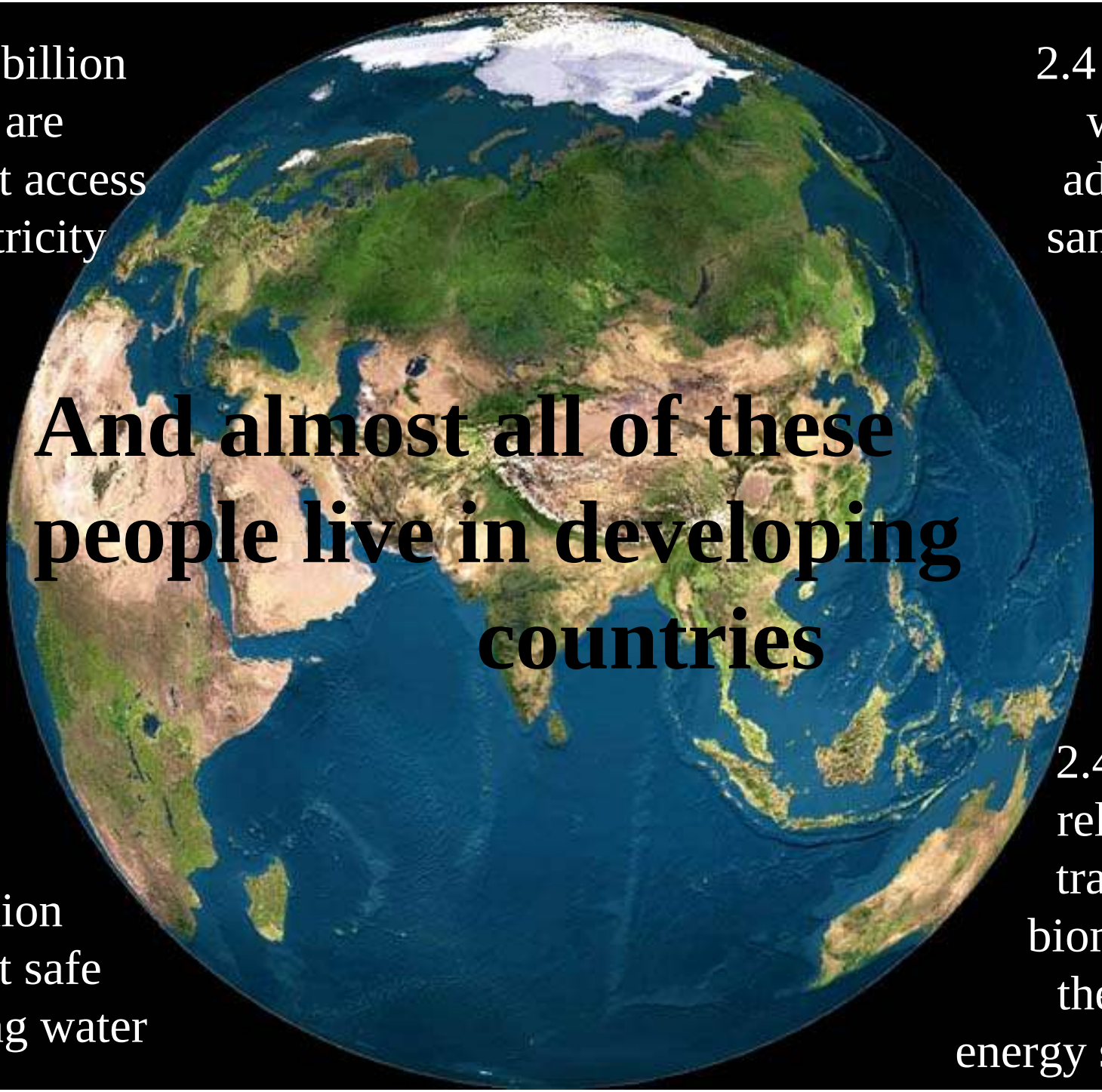


1.6 - 2 billion people are without access to electricity

2.4 billion without adequate sanitation



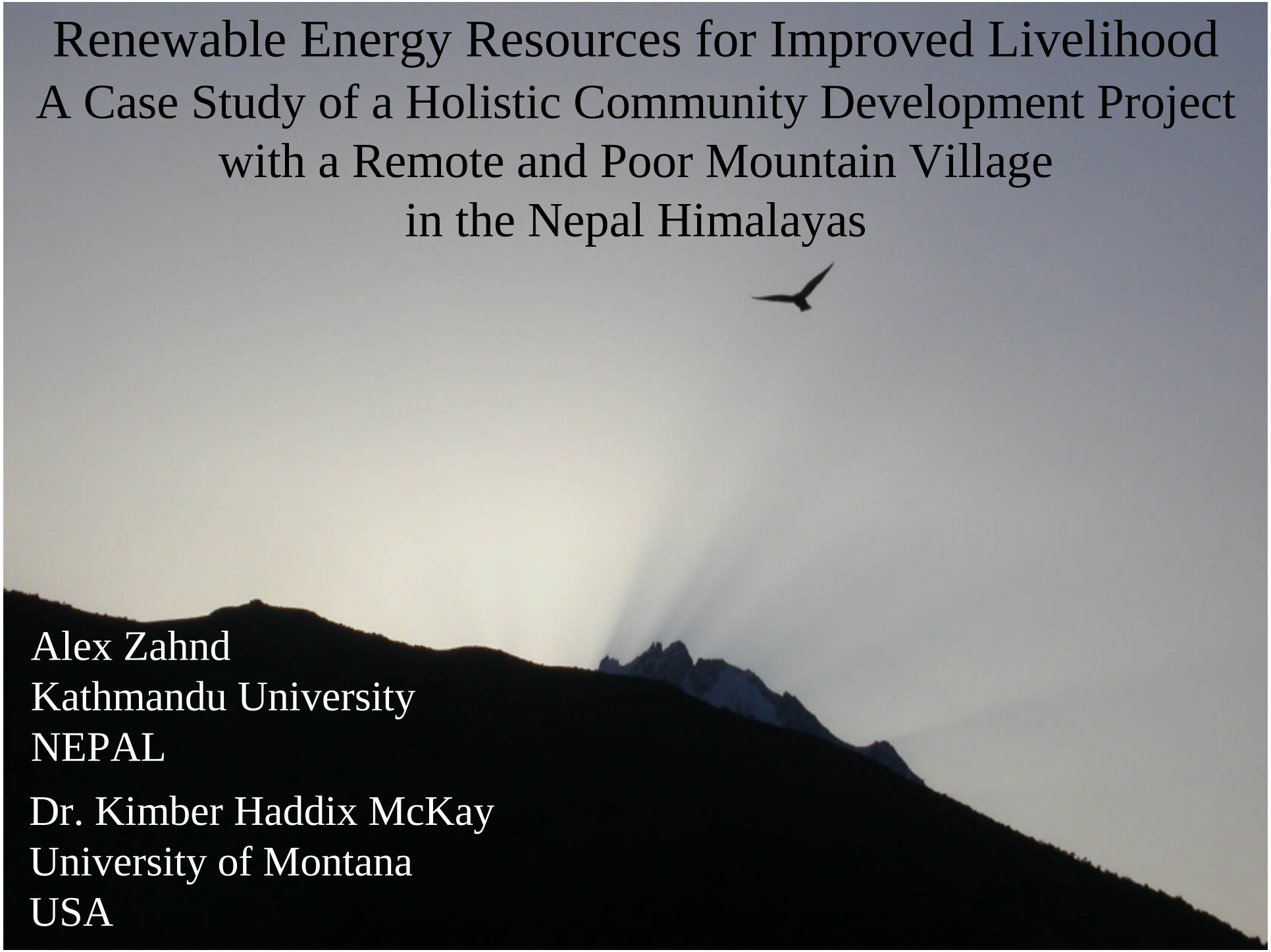
And almost all of these people live in developing countries

1.1 billion without safe drinking water

2.4 billion relying on traditional biomass for their daily energy services


NEPAL

Renewable Energy Resources for Improved Livelihood
A Case Study of a Holistic Community Development Project with a Remote and Poor Mountain Village in the Nepal Himalayas



Alex Zahnd
Kathmandu University
NEPAL

Dr. Kimber Haddix McKay
University of Montana
USA

Nepal’s Stage of Development

1. **Nepal opened its doors for the world only in 1953**
2. **Nepal still counts among the least developed countries.**
3. **Population: 28 Mio. 85 % in rural, remote mountain areas.**
4. **Average annual population growth 2.3 %.**
5. **Overall literacy rates: 40% - 60% in cities, but in the remote mountain areas 4% - 20% for both, women and men.**

Nepal's Stage of Development

6. **The average income per head per year is 30 US$ - 260 US$.**
7. **85% of Nepal's people have no access to electricity.**
8. **Annual per capita electricity consumption (2004) 68.5 kWh.**
9. **42% of Nepali live below the poverty line, and there is a clear relationship between poverty and access to electricity**

Nepal’s Renewable Energy Resources

10. **Nepal's potential hydroelectric power capacity amounts to an estimated 83,000 MW, with 42,000 MW to be technical and economical feasible.**
11. **Nepal's installed total electric generating capacity (September 2005) is 609 megawatts (MW), of which 90%, or 548 MW is hydroelectric, representing just 1.3 %**
12. **Average of 300 sunshine days a year, and daily average solar insulation of 4.5 – 5.5 kWh/m^2.**

Nepal's Stage of Development

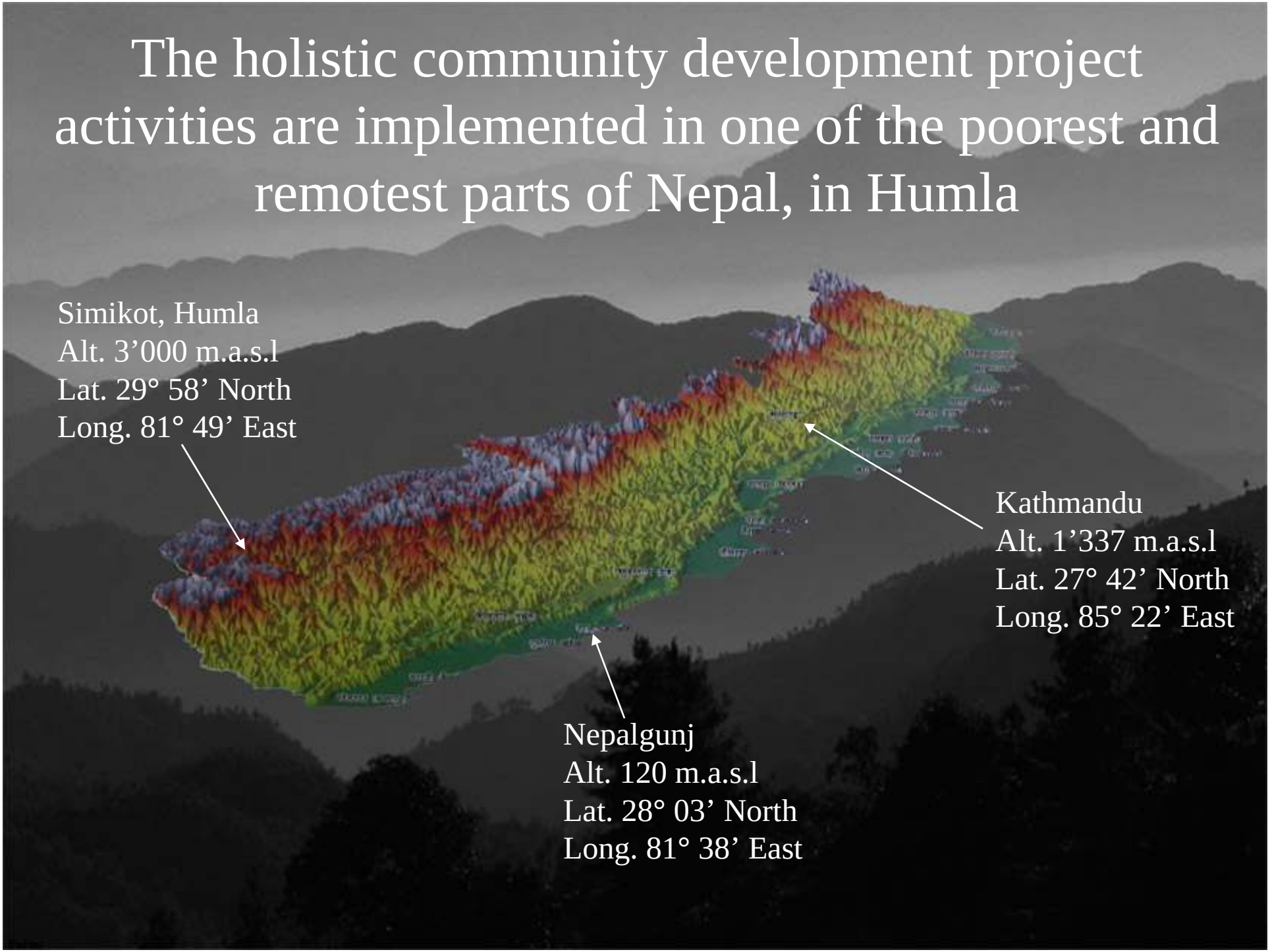
Demands a Holistic working approach, addressing the

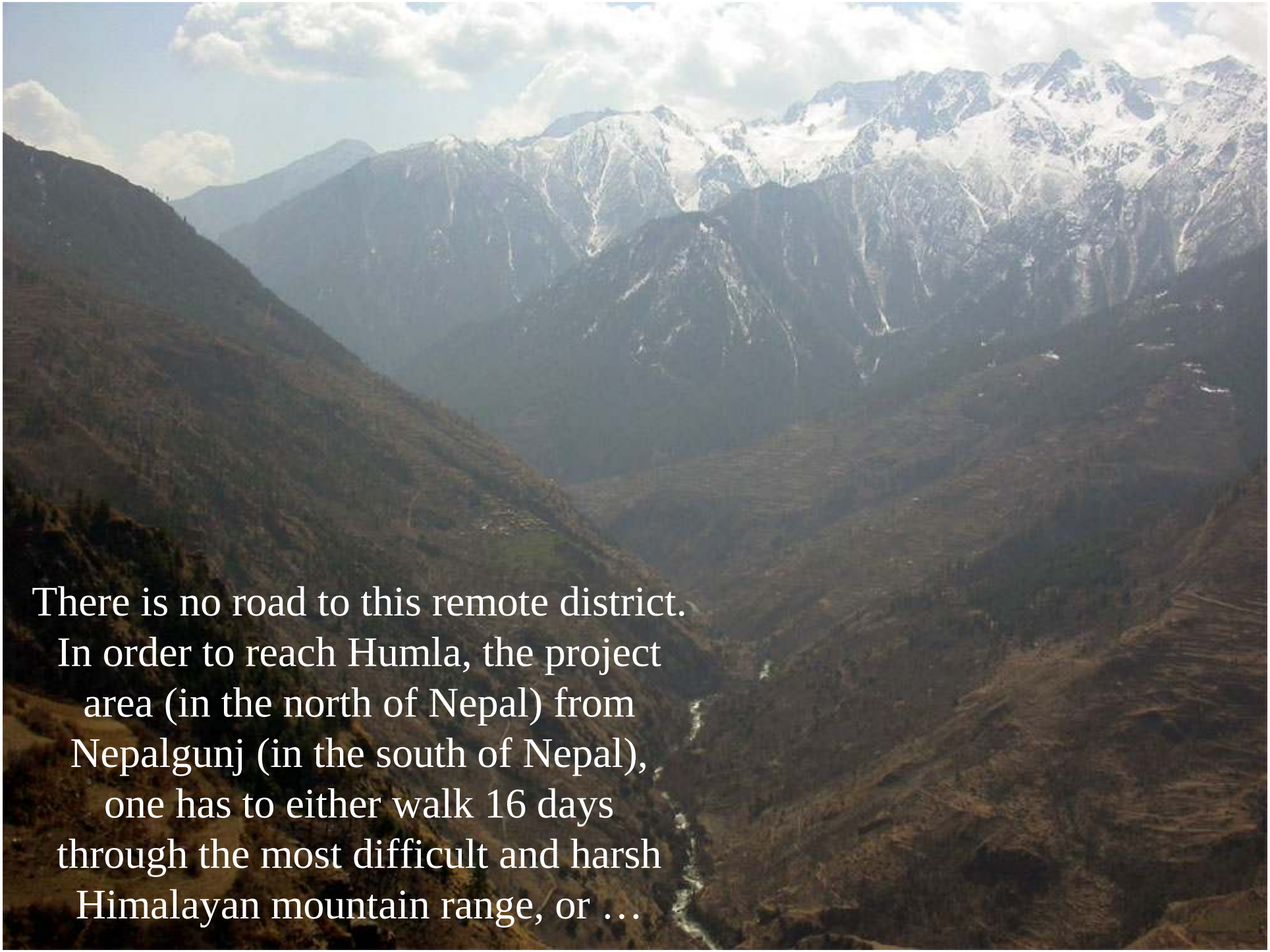
- Social
- Physical
- Mental and
- Spiritual

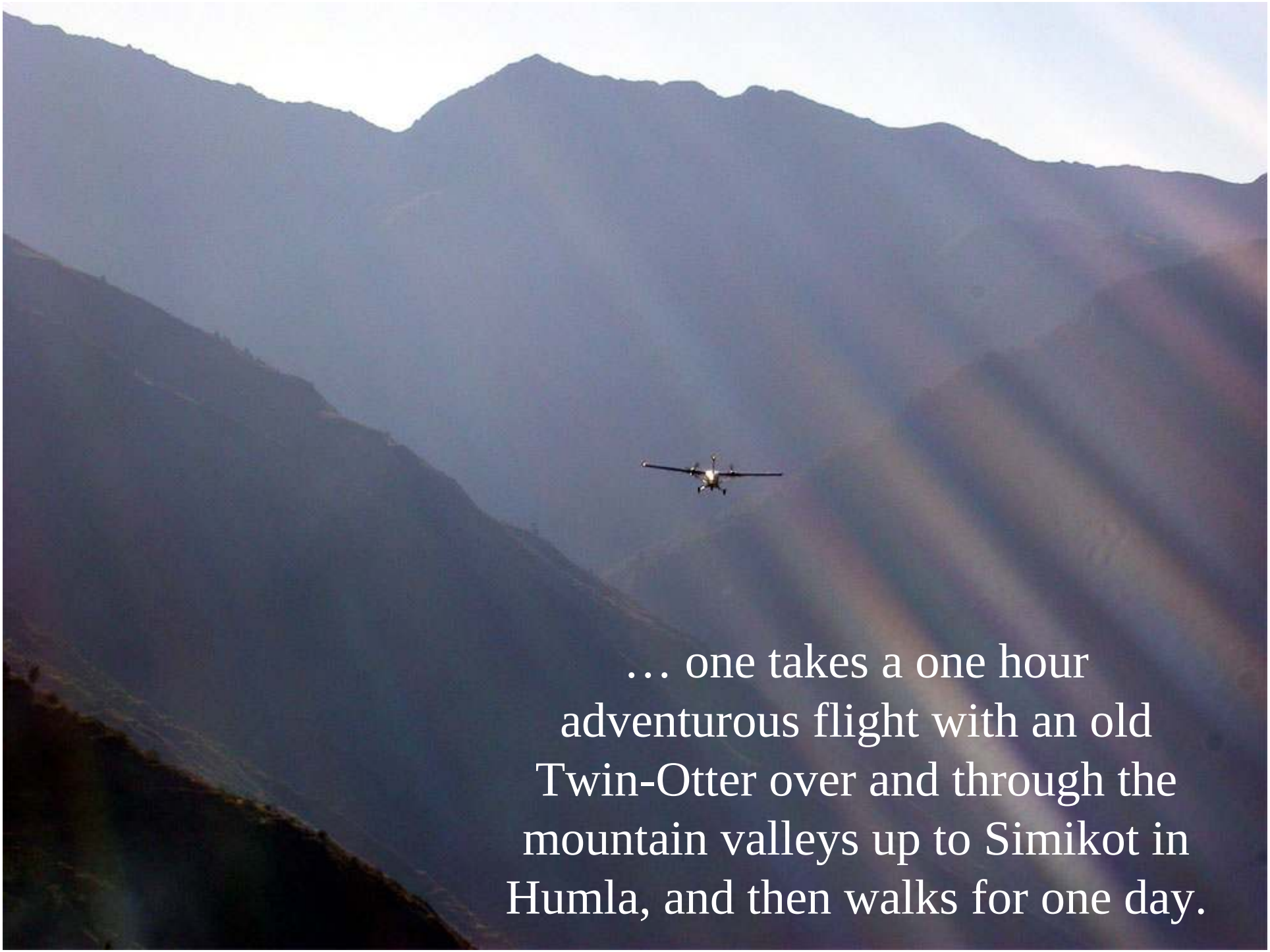
Needs of the people in sustainable ways

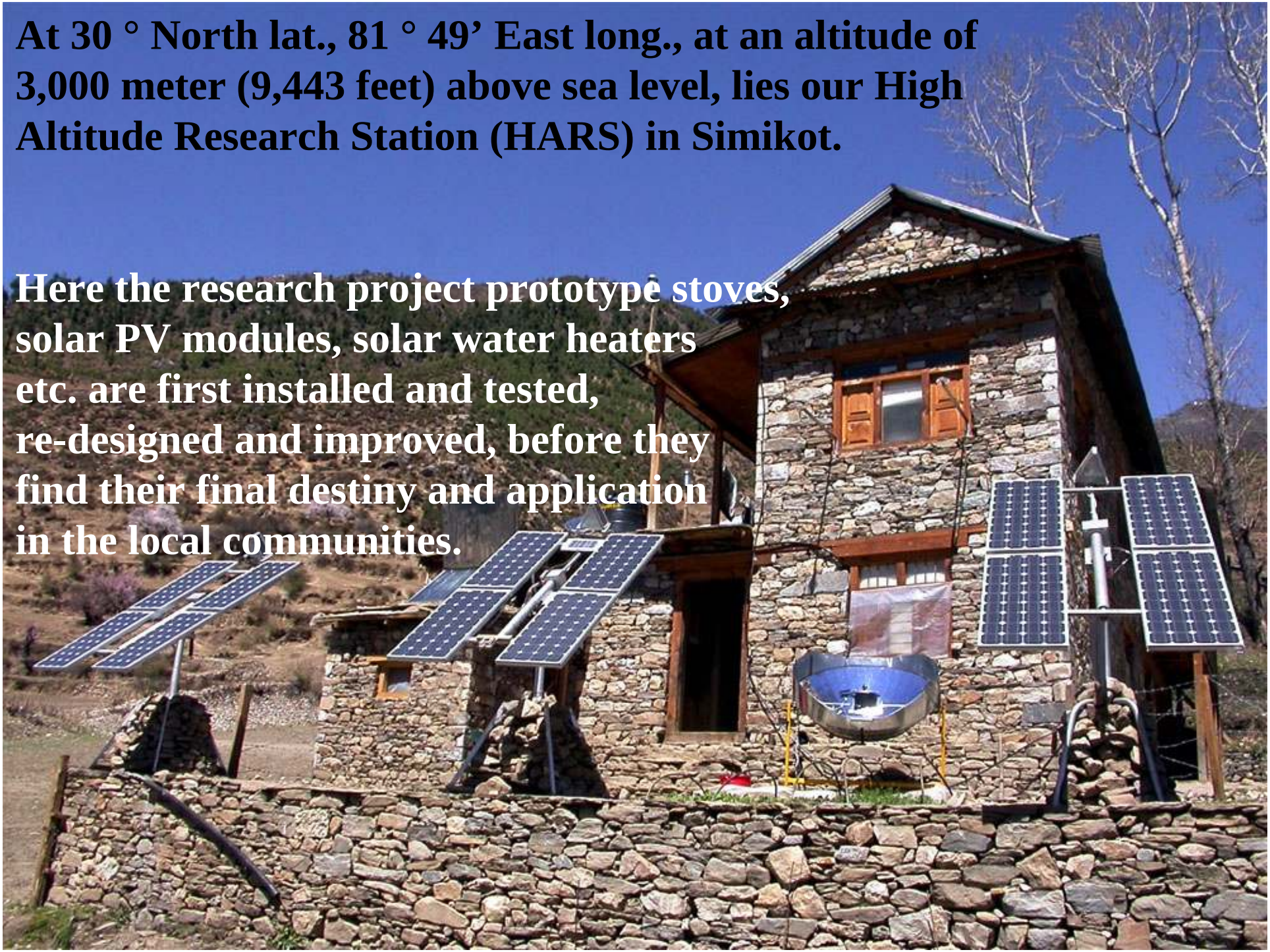
Through Holistic Community Development

The holistic community development project activities are implemented in one of the poorest and remotest parts of Nepal, in Humla



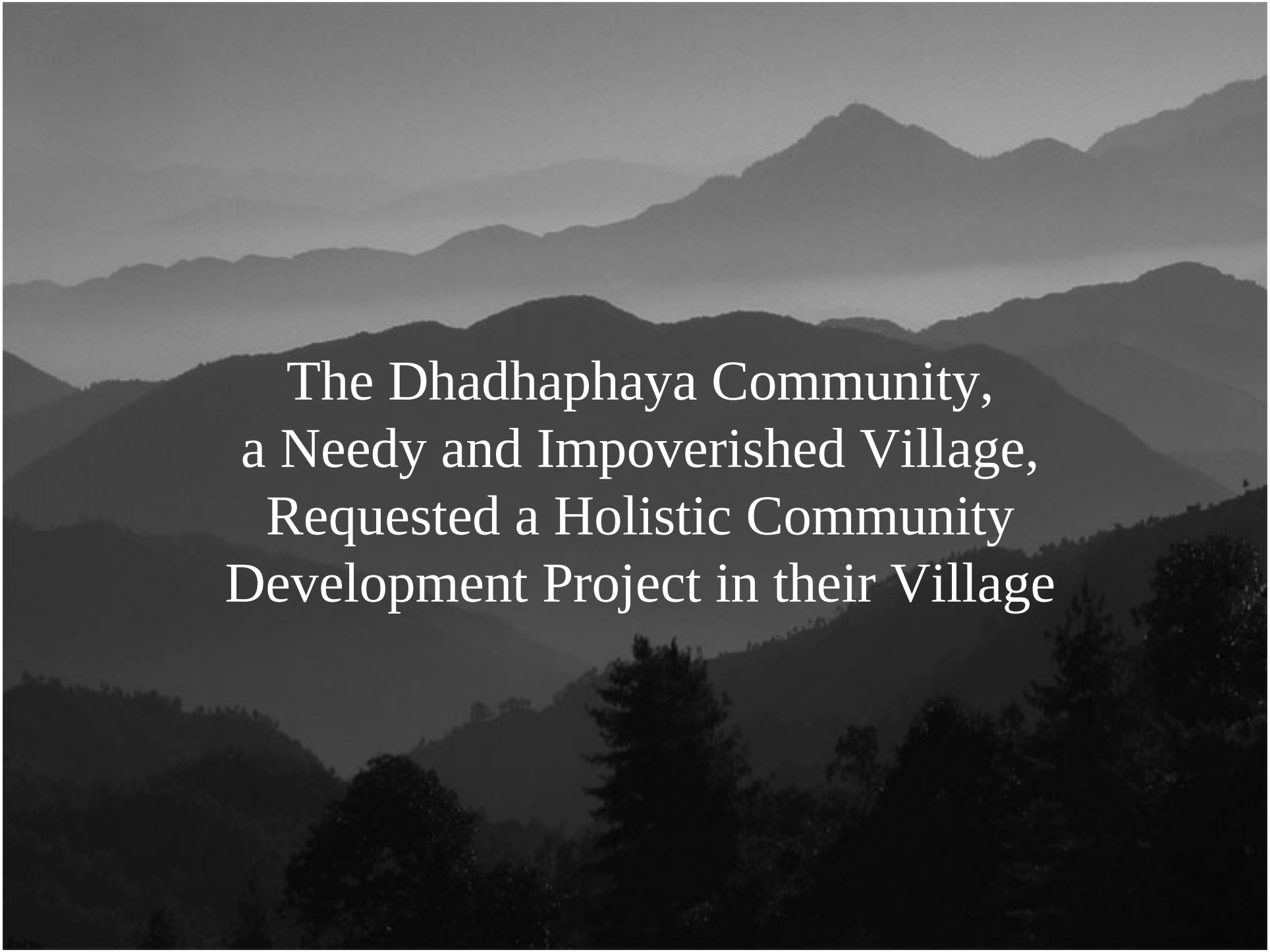

There is no road to this remote district.
In order to reach Humla, the project area (in the north of Nepal) from Nepalgunj (in the south of Nepal), one has to either walk 16 days through the most difficult and harsh Himalayan mountain range, or …

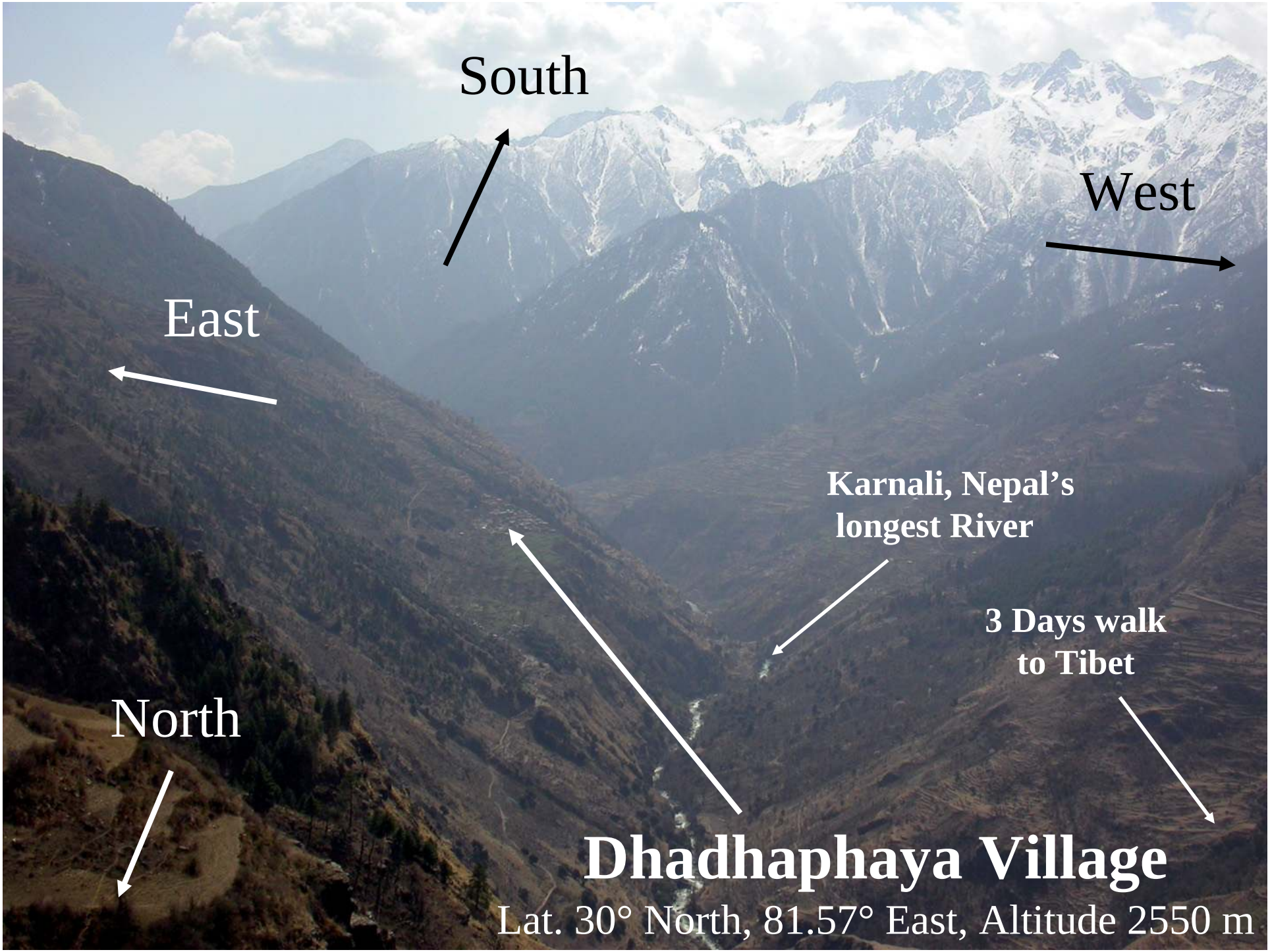

… one takes a one hour
adventurous flight with an old
Twin-Otter over and through the
mountain valleys up to Simikot in
Humla, and then walks for one day.

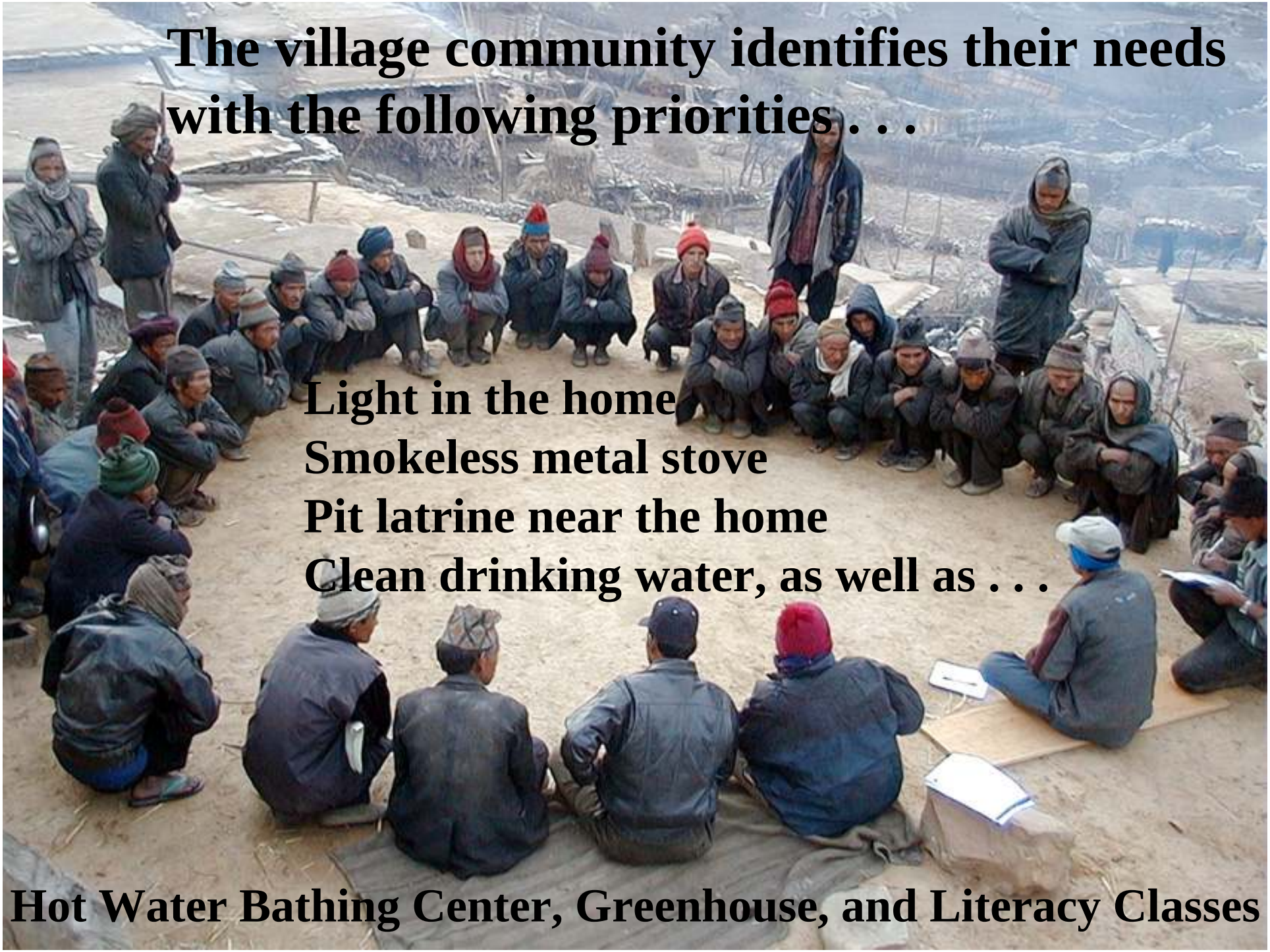

At 30 ° North lat., 81 ° 49’ East long., at an altitude of 3,000 meter (9,443 feet) above sea level, lies our High Altitude Research Station (HARS) in Simikot.
Here the research project prototype stoves, solar PV modules, solar water heaters etc. are first installed and tested, re-designed and improved, before they find their final destiny and application in the local communities.

The remote and impoverished mountain communities' needs demand particular requirements from technologies

1. Technologies must be appropriate, suitable, and apt for a particular situation, and for a particular people group.
2. Sustainability comes before efficiency.
3. Technologies need to be contextualised, to be accepted by the community, to build a strong ownership.
4. They need to aim for better living conditions, to raise the living standard of the people.


The Dhadhaphaya Community,
a Needy and Impoverished Village,
Requested a Holistic Community
Development Project in their Village


South
West
East
Karnali, Nepal's
longest River
3 Days walk
to Tibet
North
Dhadhaphaya Village
Lat. 30° North, 81.57° East, Altitude 2550 m

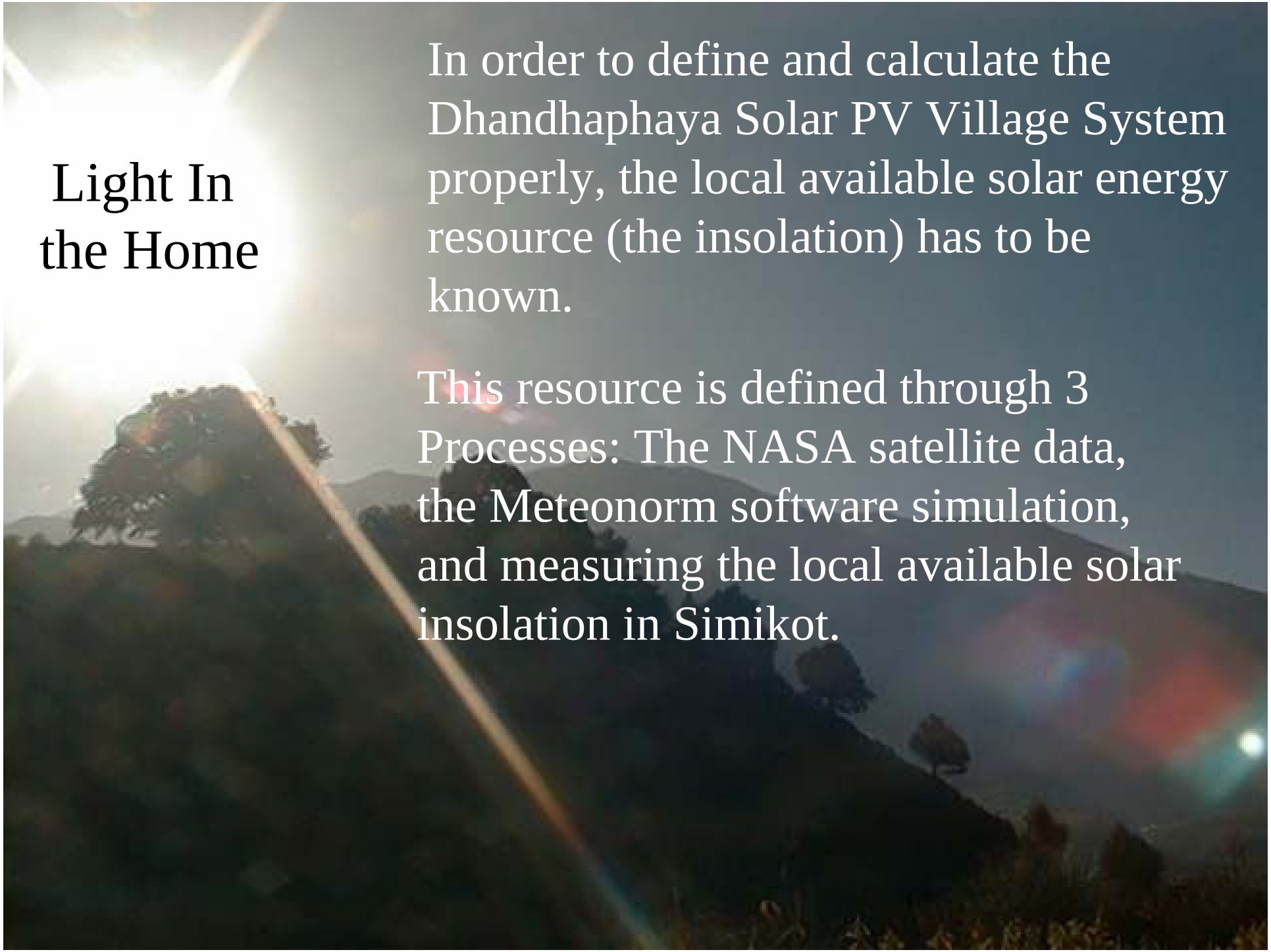

The village community identifies their needs with the following priorities . . .
Light in the home
Smokeless metal stove
Pit latrine near the home
Clean drinking water, as well as . . .
Hot Water Bathing Center, Greenhouse, and Literacy Classes

Dhadhaphaya Village

The Village situation in 2004:

- **167 homes, and 1,067 people**
- **No house had light**
- **All homes cooked on open fires**
- **No home had a toilet**
- **All drank dirty river water**

Dhadhaphaya Village
29° 59' Northern Latitude, 81° 48' Eastern Longitude, at 2,550 m (8,366 feet) altitude
Population (August 2005): 167 homes with 1,067 peoples. One primary school class 1-7, one health post



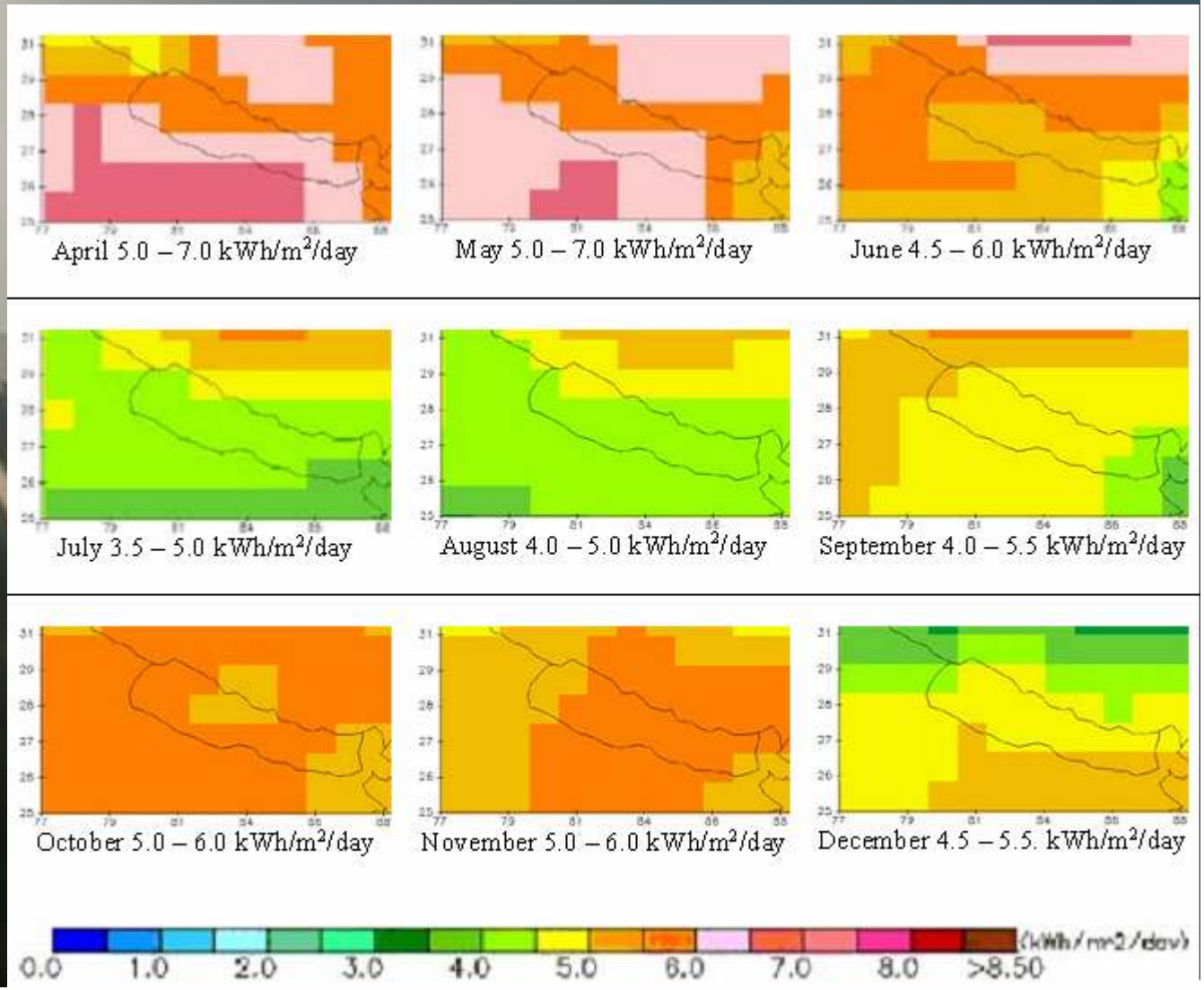
Light In the Home

In order to define and calculate the Dhandhaphaya Solar PV Village System properly, the local available solar energy resource (the insolation) has to be known.

This resource is defined through 3 Processes: The NASA satellite data, the Meteonorm software simulation, and measuring the local available solar insolation in Simikot.

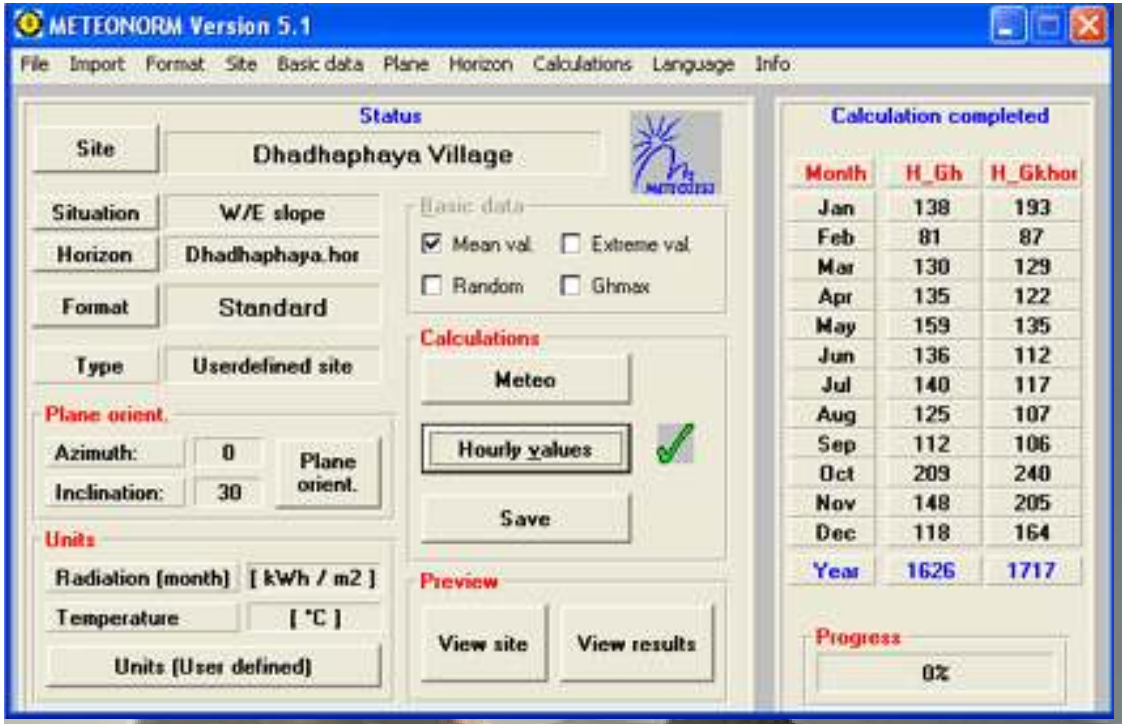
NASA Data

Average 30º towards Equator Tilted Solar Irradiation from 1983 –1993 for Nepal from NASA (http://eosweb.larc.nasa.gov/)

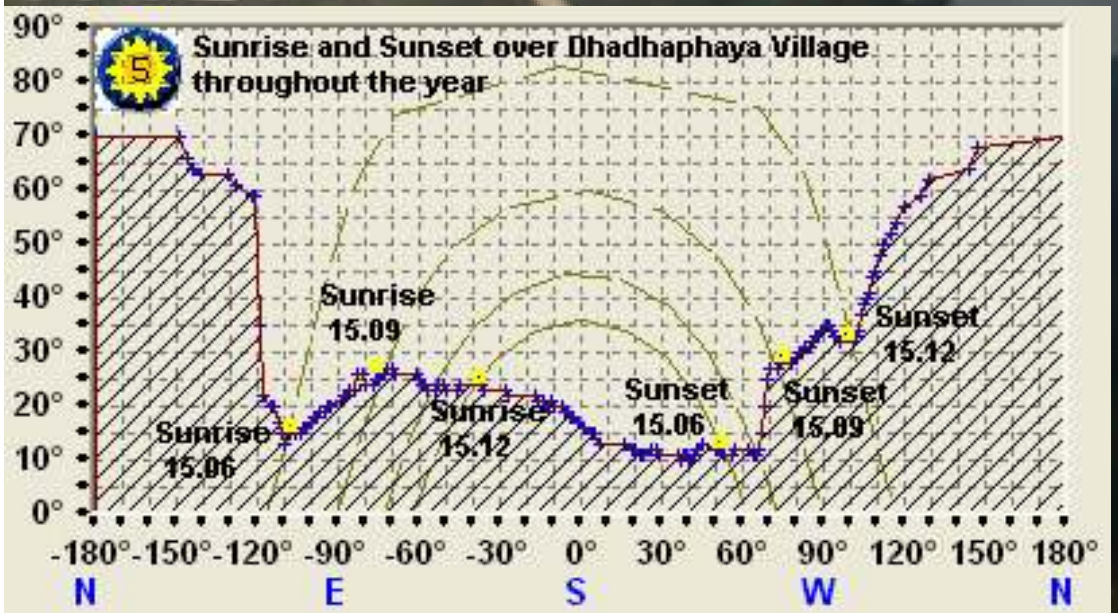


Average Annual Daily Solar Insolation for Dhadhaphaya Village, at 30° North, and 2’550 m.a.s.l. is ~ 5.2 kWh/m^2 on a 30 ° south tilted surface


METEONORM
Solar Insolation
Simulation
Software

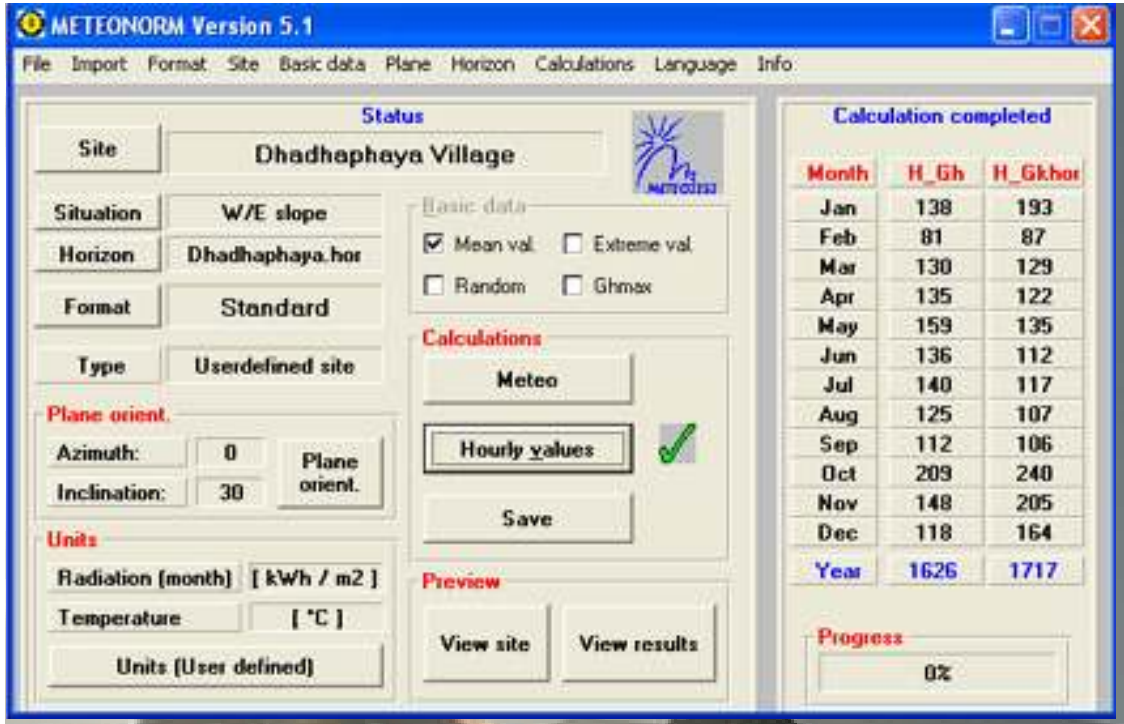


For the Dhadhaphaya Village



Included in the Simulation is the 360 ° Horizon around Dhadhaphaya

Simulated Dhadhaphaya Solar Insolation Data with Horizon, on a 30° South Tilted Surface



Site: Dhadhaphaya Village
Situation: W/E slope
Horizon: Dhadhaphaya.hor
Azimuth: 0
Type Userdefined site
Inclination: 30
Format Standard

All radiation datas are influenced by a high horizon!
The ending "hor" means with high horizon
Albedo = 0.25

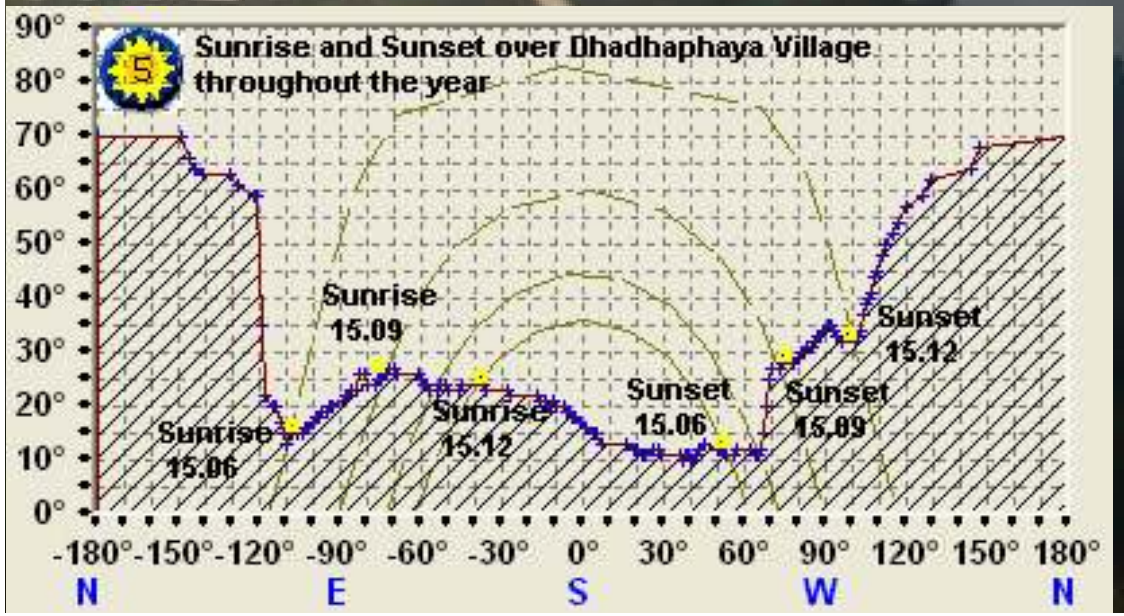
	Jan	H_Gh	H_Dh	H_Gkhor	H_Dkhor	H_Bnhor	Ta
	Jan	138	32	195	48	181	6.1
	Feb	81	47	88	44	53	6.7
	Mar	130	63	131	61	84	10.3
	Apr	135	73	124	67	73	14.7
	May	159	90	138	80	80	18.9
	Jun	136	81	114	70	64	17.5
	Jul	140	70	119	63	81	18.3
	Aug	125	79	109	69	54	18.1
	Sep	112	55	108	51	69	15.3
	Oct	209	35	244	51	231	13.7
	Nov	148	30	208	49	195	10.7
	Dec	118	34	166	48	148	8.1
	Year	1626	689	1744	702	1313	12.7

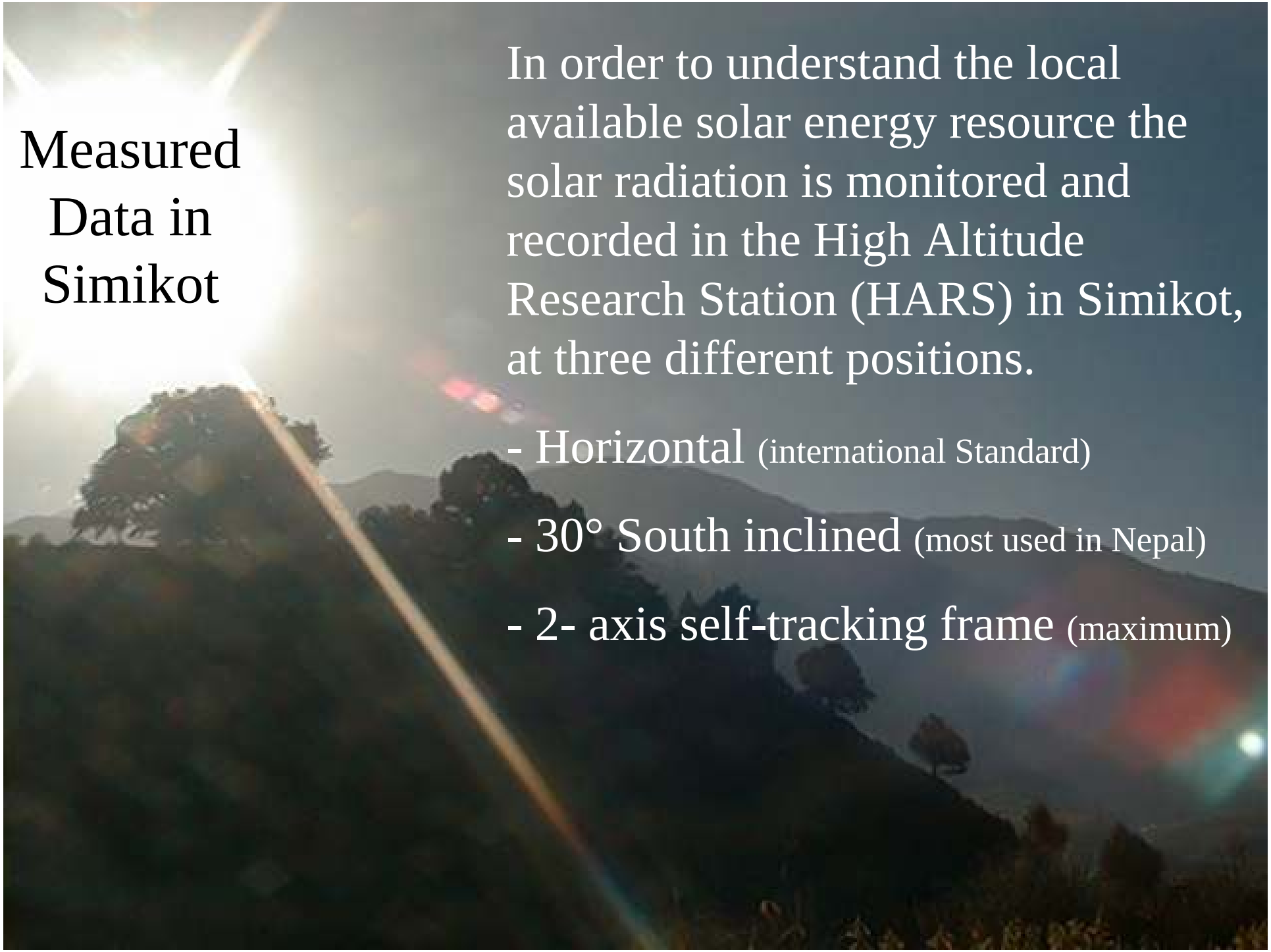
Legend:

H_Gh: Irradiation of global radiation horizontal
H_Dh: Irradiation of diffuse radiation horizontal
H_Gkhor: Irradiation of global rad., tilted plane, with high horizon
H_Dkhor: Irradiation of diffuse rad., tilted plane, with high horizon
H_Bnhor: Irradiation of beam, with high horizon
Ta: Air temperature

Radiation in [kWh/m²]
Temperature in [°C]
Gh: Mean values of climate zone
Ta: Only 1 station(s) for interpolation

For the Dhadhaphaya Village



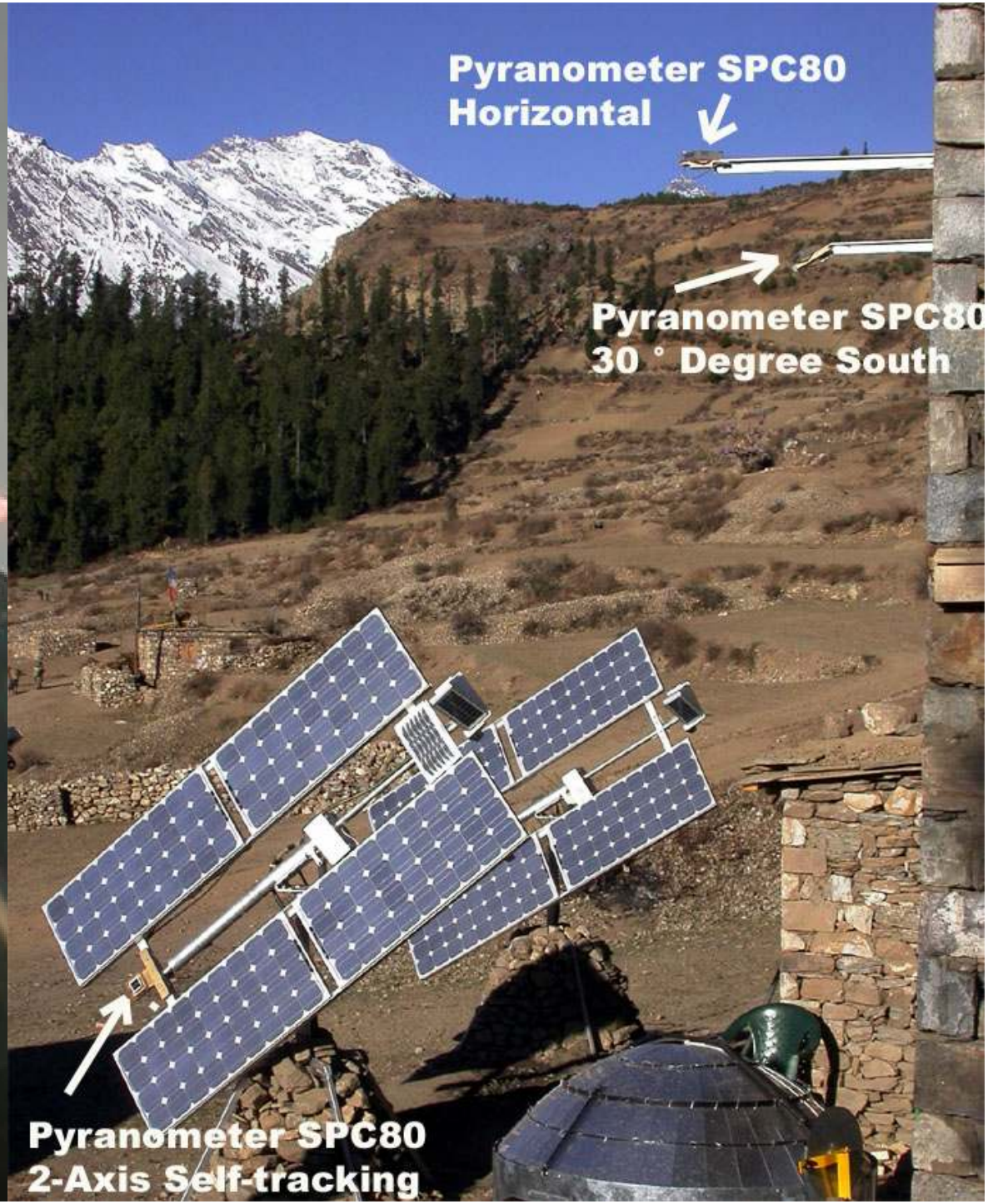


Measured Data in Simikot

In order to understand the local available solar energy resource the solar radiation is monitored and recorded in the High Altitude Research Station (HARS) in Simikot, at three different positions.

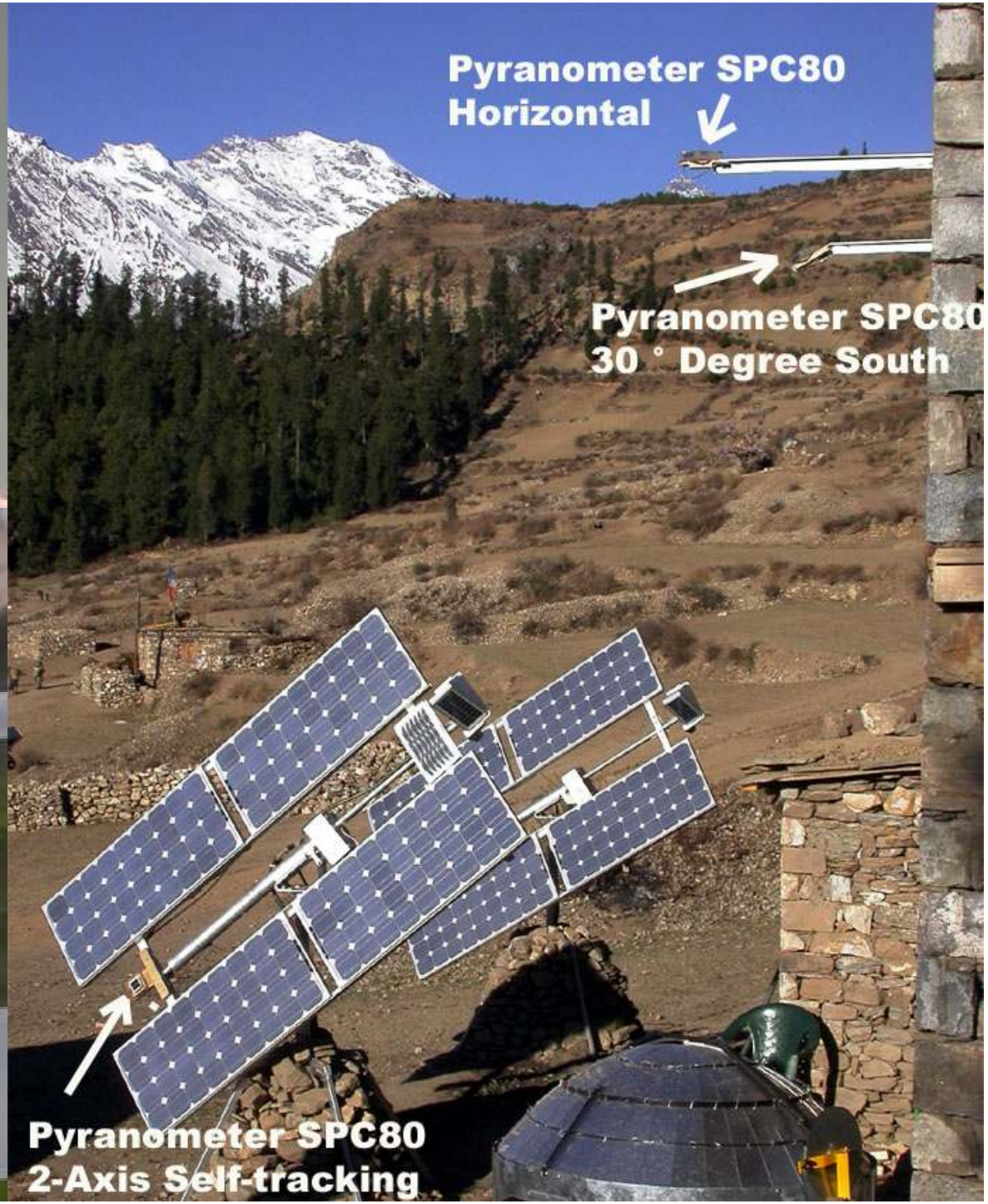
- Horizontal (international Standard)
- 30° South inclined (most used in Nepal)
- 2- axis self-tracking frame (maximum)

Measured Data in Simikot

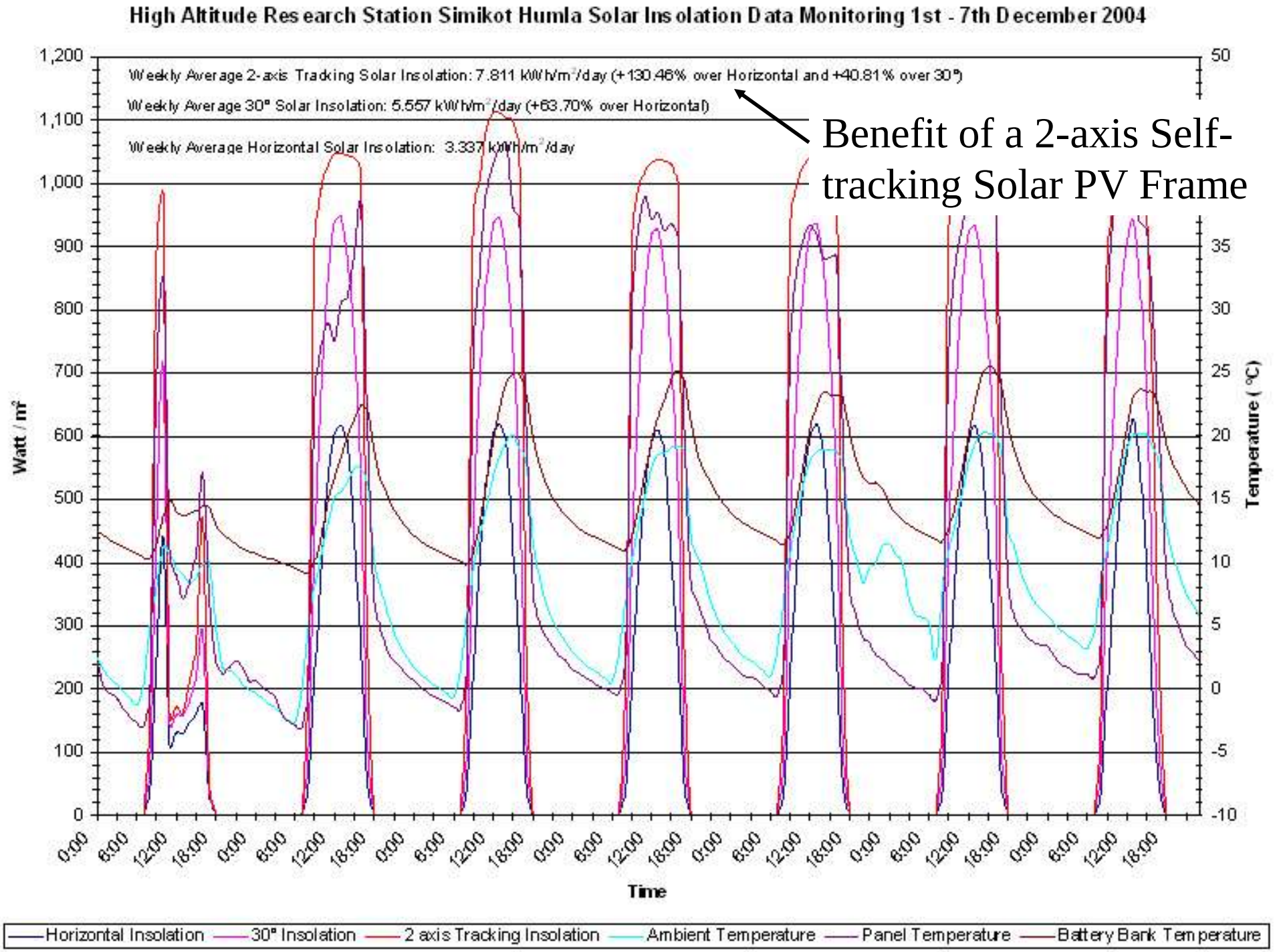


Measured Data in Simikot

SPC 80 Pyranometer from SolData Denmark

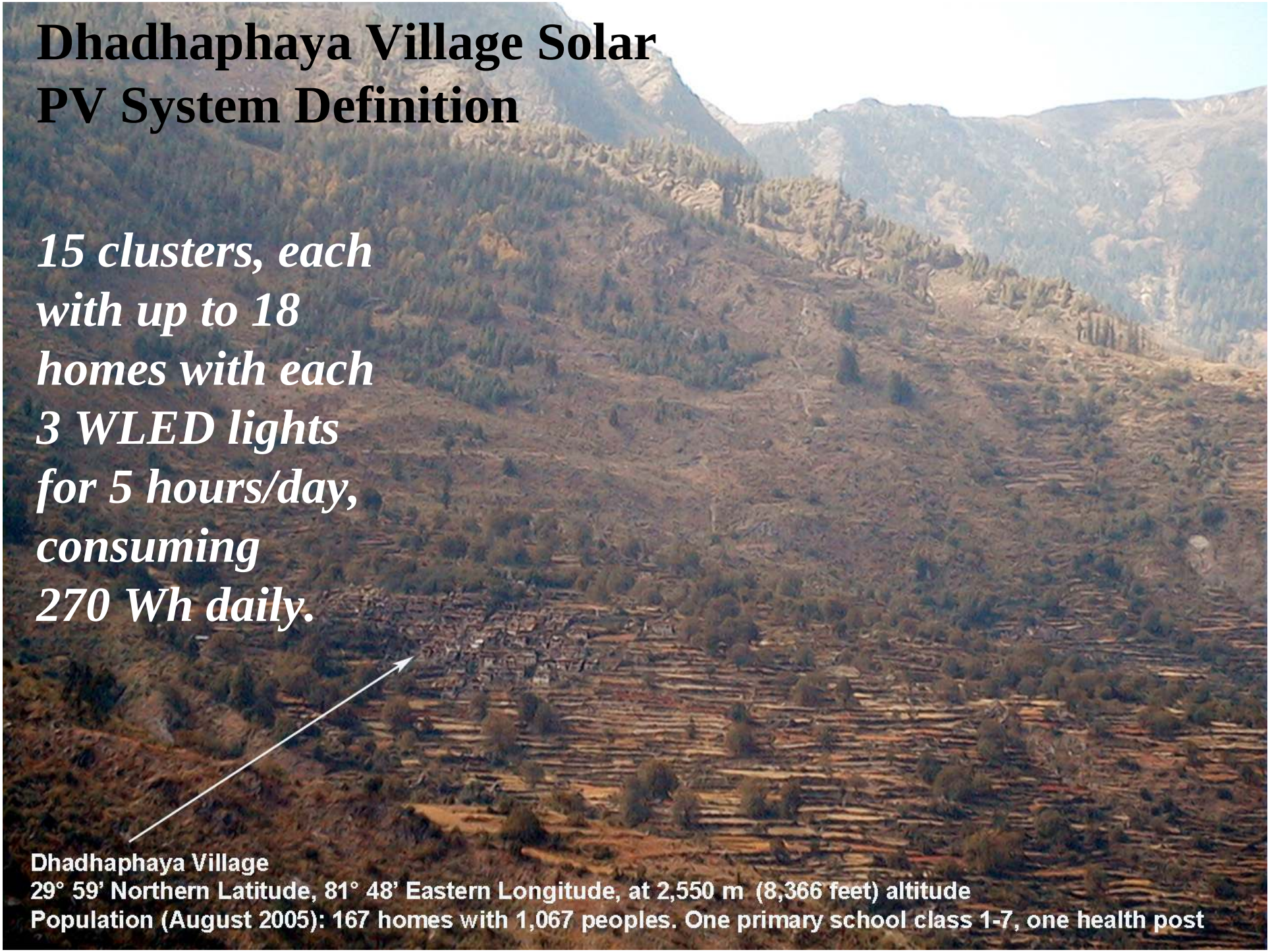


Example of one Week Recorded Solar Insolation with three Pyranometers on different surfaces, as well as Ambient, Solar PV Module and Battery Bank Temperature from the 1st – 7th December 2004, in Humla Nepal


High Altitude Research Station Simikot Humla Solar Insolation Data Monitoring 1st - 7th December 2004
Weekly Average 2-axis Tracking Solar Insolation: 7.811 kWh/m²/day (+130.46% over Horizontal and +40.81% over 30°)
Weekly Average 30° Solar Insolation: 5.557 kWh/m²/day (+63.70% over Horizontal)
Weekly Average Horizontal Solar Insolation: 3.337 kWh/m²/day
Benefit of a 2-axis Self-tracking Solar PV Frame
Watt / m²
Temperature (°C)
Time
Horizontal Insolation
30° Insolation
2 axis Tracking Insolation
Ambient Temperature
Panel Temperature
Battery Bank Temperature

Dhadhaphaya Village Solar PV System Definition

15 clusters, each with up to 18 homes with each 3 WLED lights for 5 hours/day, consuming 270 Wh daily.



Dhadhaphaya Village Solar PV System Definition

Solar Energy Resource: Daily Average Solar Radiation 4.778 kWh/m^2
(Meteonorm simulation with high horizon)

Each cluster has one 75 W solar PV module, seasonally adjustable. Up to 5 Days the Battery Bank will provide Energy Independent from the Sun

Dhadhaphaya Village
29° 59' Northern Latitude, 81° 48' Eastern Longitude, at 2,550 m (8,366 feet) altitude
Population (August 2005): 167 homes with 1,067 peoples. One primary school class 1-7, one health post

Training and Hands – On Practical Installation

Creating Ownership

Each Household Participates in the Building and Underground Cabling

Ten chosen Local People have been Trained to Look After and Maintain the Solar PV Systems

Thus Dadhaphaya Village has

15 Clusters with each a 75 Watt Solar PV Module powering total 501 x 1 Watt WLED Lights

in 167 Homes


No Smoke - Less Firewood
Smokeless
Metal Stove
in the Home

No Smoke - Less Firewood

Open Fire Place, the Homes Full of Smoke. The Daily Firewood Consumption is as high as 30 kg – 50 kg, and the Health of Women and Children is in great danger.

No Smoke - Less Firewood

No Smoke insides Homes through a Smokeless Metal Stove. Daily 40% - 50% less Firewood Consumption. Great Improved Health Conditions.

Open Fire Place, the Homes Full of Smoke. The Daily Firewood Consumption is as high as 30 kg – 50 kg, and the Health of Women and Children is in great danger.

1. Improved Health
2. Improved Hygiene
3. Cleaner Walking Paths
4. Cleaner Fields
5. Cleaner Rivers

Pit Latrine


For healthy Families

Pure and Clean Drinking Water

In close partnership with the local community the drinking water system is defined, and planned.

Pure and Clean Drinking Water

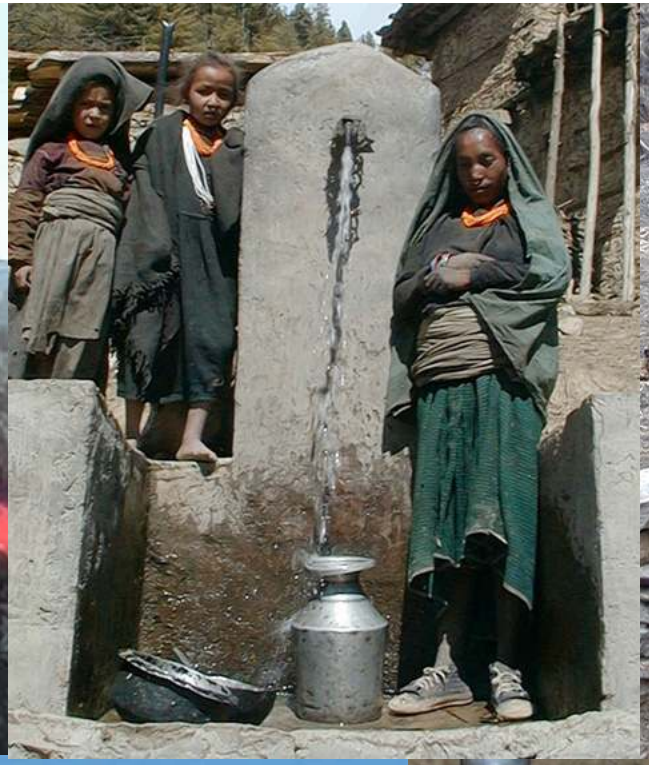
In close partnership with the local community the drinking water system is defined, and planned. Where the pipes have to go through, where the water taps have to be, are issues decided by the community. The whole system is built together and enjoyed together . . .

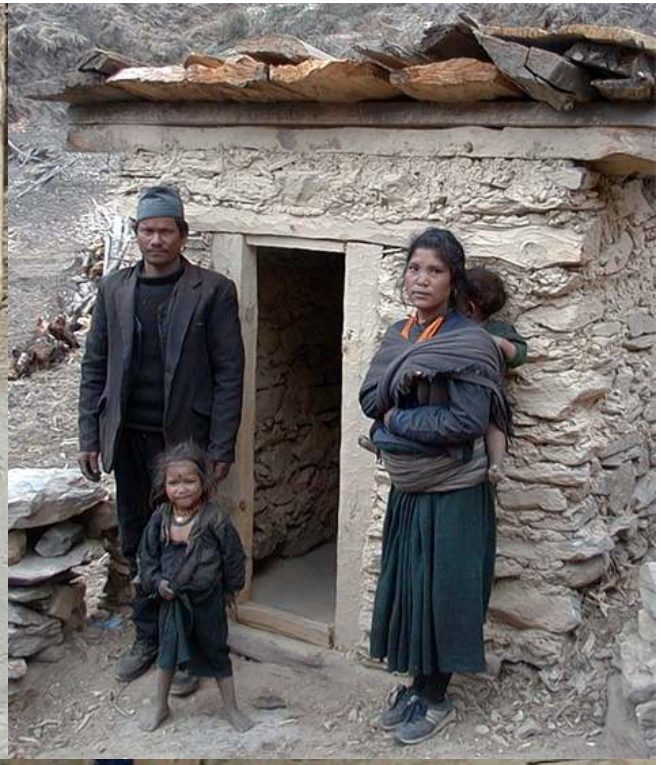
Pure and Fresh Drinking Water

To have participated in the building of the own village drinking water system increases also the interest to keep it maintained and running.

Pure and Fresh Drinking Water

To have participated in the building of the own village drinking water system increases also the interest to keep it maintained and running.





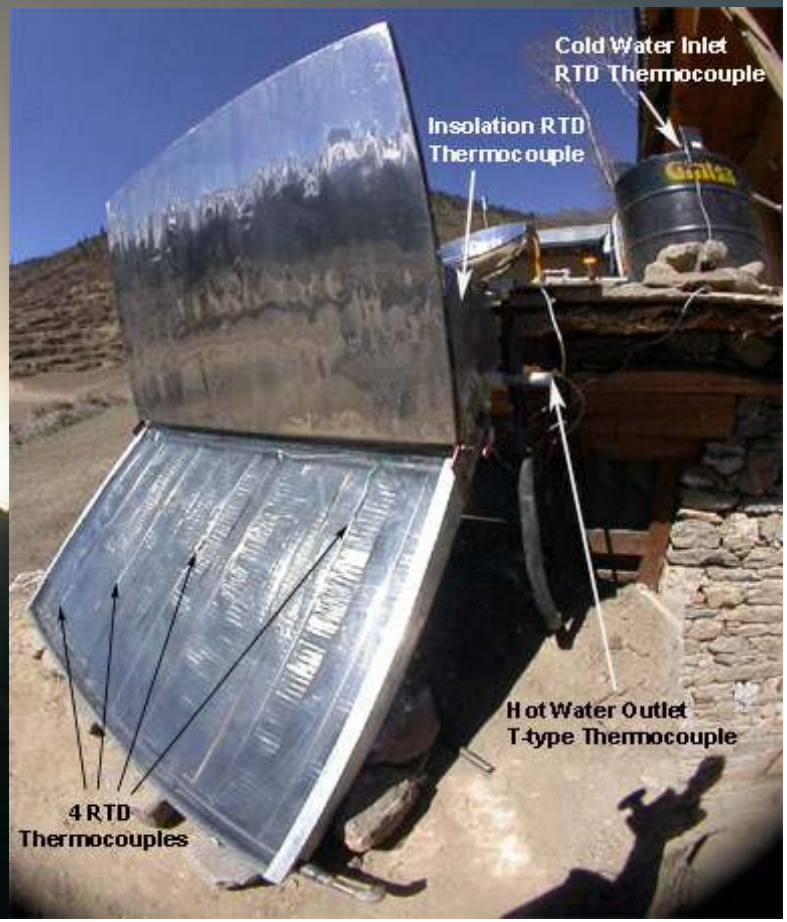
Thus the Basic Issues to Address in a Holistic Community Development Project in the impoverished Nepal Himalayas is . . .


Water
Pit Latrine
the Family of 4: Light, Stove, Pit Latrine, Water
Light
Stove
PLUS . . .

High Altitude Solar Water Heater Bathing Center

First High altitude Solar Water Heater Prototype since 2003 under test

Hot Water



High Altitude Solar Water Heater Bathing Center

appropriate version has emerged

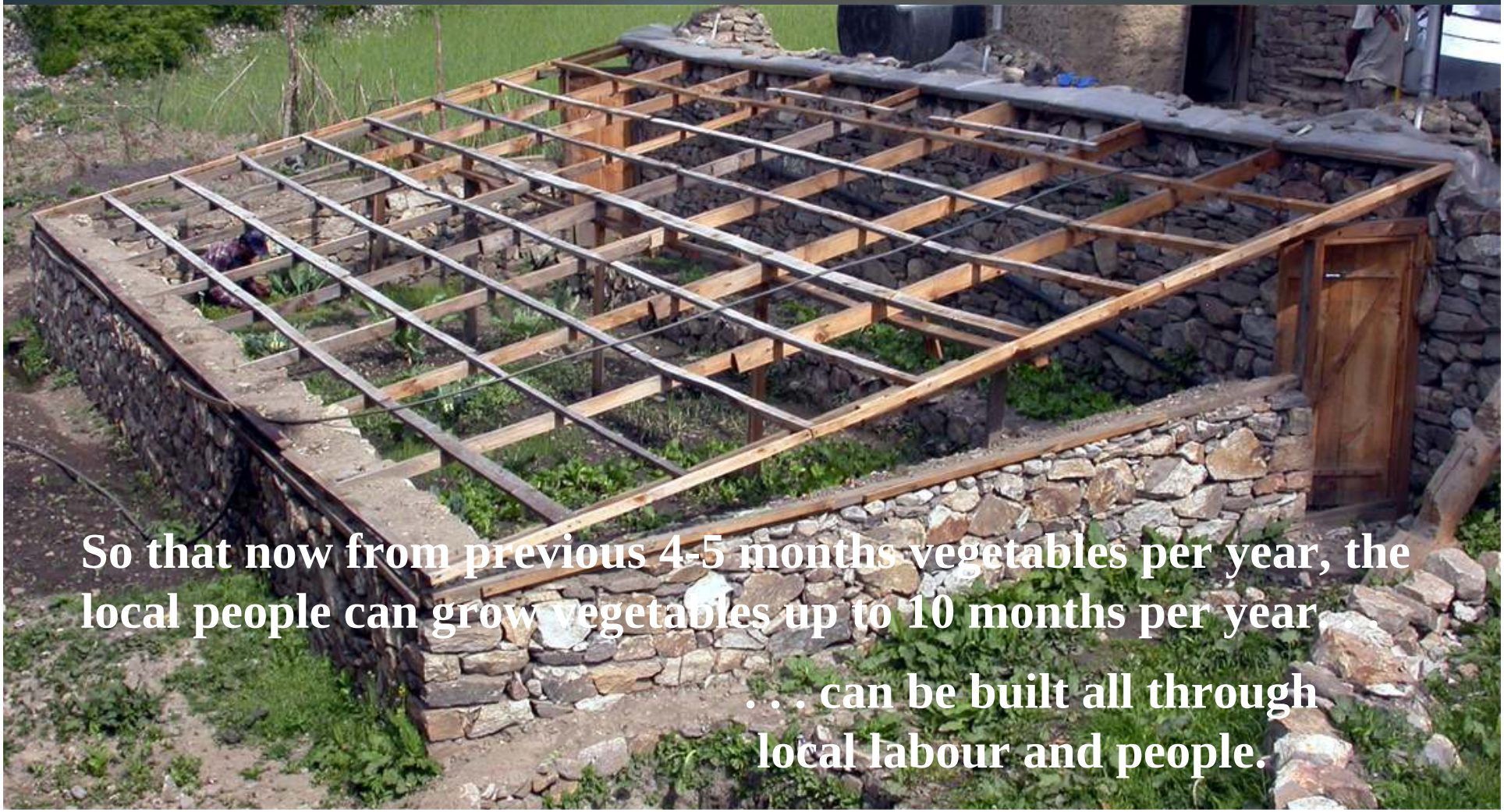
Hot Water

Followed by improved versions and tests, till the final . . .

For Increased, and More Nutritious Food

For Increased, and More Nutritious Food

With the local materials wood and stones, and UV stabilised plastic from Kathmandu for the winter months, a suitable greenhouse . . .



So that now from previous 4-5 months vegetables per year, the local people can grow vegetables up to 10 months per year . . .

. . . can be built all through local labour and people.

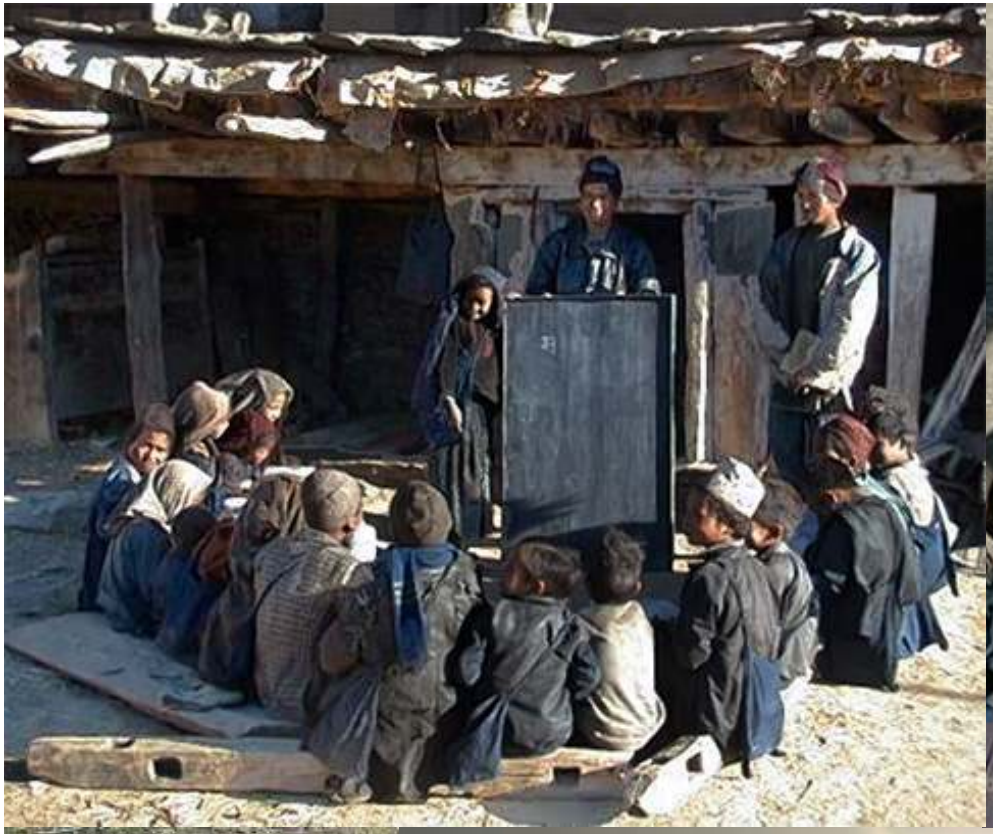

So that now from previous 4-5 months vegetables per year, the local people can grow vegetables up to 10 months per year. . .
. . . improving the diet and thus the health of adults and in particular their small children enormously.

Humla's literacy rate for women is 4.8%

Girls are not sent to school

NFE

(Non-Formal-Education)



NFE

(Non-Formal-Education)

Now there are NFE classes for women and children

Expected Impacts

If the hypothesis, that a holistic community development projects will have long-term synergetic benefits is correct, the yearly conducted survey will show expected impacts such as:

- Overall Improvement in the Living Conditions
- Increased Health and Hygiene of all people
- Decrease in Firewood Consumption and work load
- Increase in the Women Literacy Rate and Awareness
- Increase in Social Gatherings after Dark resulting in
- Increased Community Development Projects
- High Utilisation and Low Breakdown of the New Technologies


Can this Project be Sustainable ?
Technically . . .
Economically . . .
Socially . . .
Environmental . . . ?

Strive for Sustainability

Technical Sustainability

Reliable components
Sound design
Local O & M services

Economic Sustainability

Least-cost preferred systems
Services that consumers can afford
Periodical fee collection

Social Sustainability

Participation of all stakeholders
Training of consumers (system use, safety & maintenance)
Cultural acceptance by end user

Environmental Sustainability

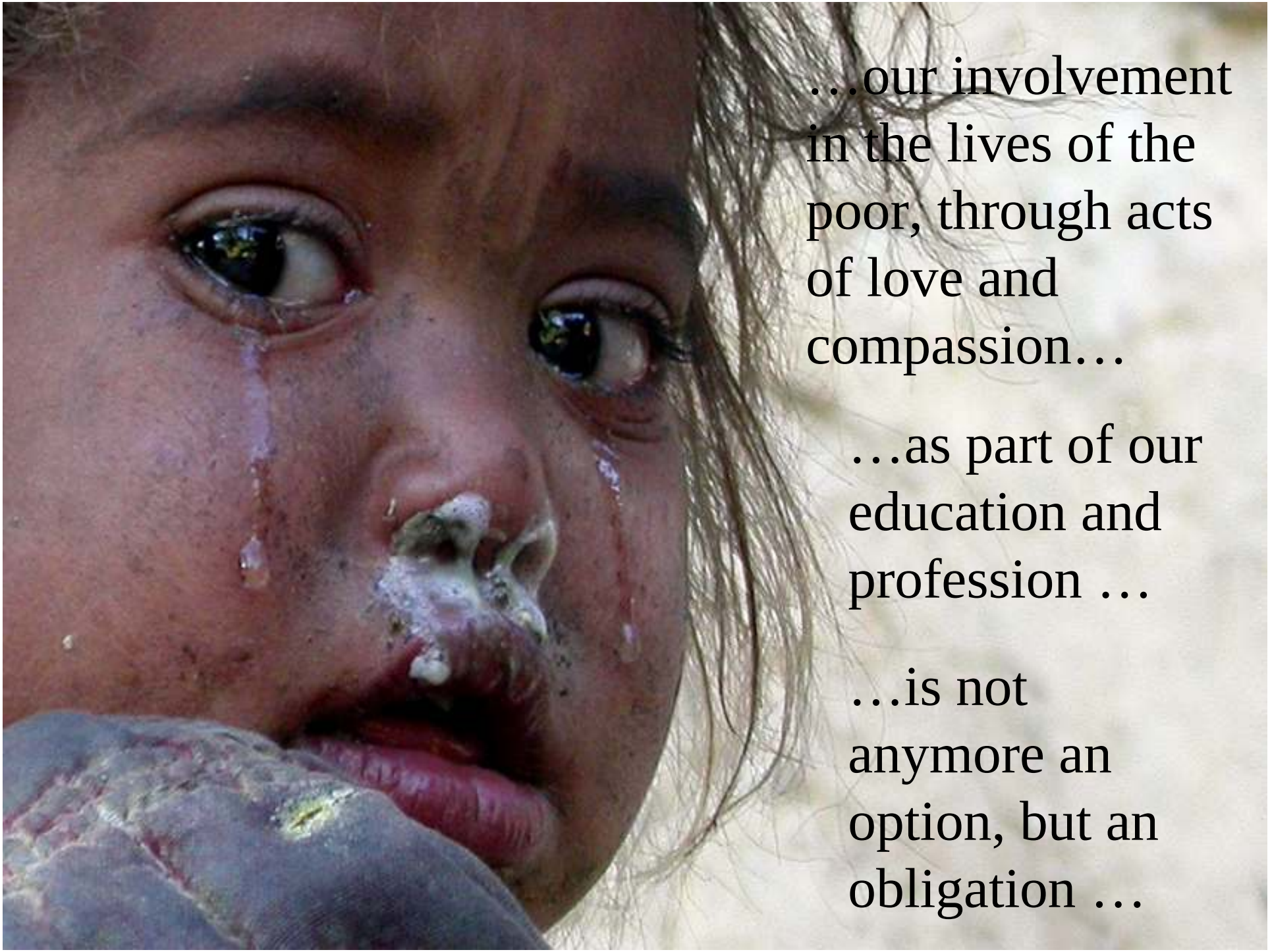
No ecological impact through installation and operation
Removal/recycling of batteries, lubricants

Sustainable, Appropriate Technology Projects Can Answer Positively to . .

1. Have the needs of all Stakeholders been met ?
2. Is it the best mix of energy and technology: Least-Cost - Preferred by the Community – Sustainable ?
3. Have the Local People Participated from the Start ?
4. Has the local Community defined the "Rules of the Game" ?
5. Have local people be appropriately trained for competent Operation and Maintenance ?
6. Has Sustainability be considered before Efficiency ?
7. Have new Activities and Opportunities been created ?
8. Have the overall living conditions improved ?

Major Obstacles to Successful Projects serving marginalised, poor Communities

1. **History of expectation of free equipment delivery**
2. **High capital and transport cost, due to remoteness**
3. **Deep rooted poverty**
4. **No/minimal and poor education/knowledge**
5. **No community institution to install, service, collect**


…our involvement in the lives of the poor, through acts of love and compassion…
…as part of our education and profession …
…is not anymore an option, but an obligation …

For more Info:

Alex Zahnd

Email: azahnd@wlink.com.np