LAND OF PLENTY

Final presentation
Laura Smits
April 20th, 2012
Living in poverty
58%($1.25), 80%($2)
Introduction to Haiti

Manufacturing

Optimal location

laurasmits@gmail.com

april 20, 2012

Research set-up
Planning strategy
Conclusions

Dead toll: 316,000
Source: Oxfam, 2010

Still homeless (2011): 800,000
Source: Oxfam, 2010

Living in slums: 1,100,000
Source: IHSI, 2003

Urban population: 47%
Source: UNICEF, 2010

Too low birthweight: 25%
Source: WHO, 2010

Cholera (cases, exp. cases): 171,000, 400,000
Source: Worldbank

Literacy rate: 35%
Source: super-economy.blogspot.com

Aid/remittances share in GDP (10%/18%)
Source: UNICEF

Using internet (2008): 10%

Living in poverty: 58% ($1,25), 80% ($2)
Source: OXFAM, 2011

Malnutrition (2005): 58%
Source: UN, 2007

Using improved sanitation: 17%
Source: UNICEF, 2010

Forested land (2008): 1.5% (natural 60%)
Source: The Guardian

No formal job: 2/3 of population
Source: UNICEF

Primary/Secondary school attendance rate (50/20%)

Source: NASA, 2010

Source: Oxfam, 2010

POLITICAL INSTABILITY

(Ramon Espinosa, 2010)
URBAN PLANNING
RECONSTRUCTION
DEVELOPMENT
LOCAL MANUFACTURING
IN THE COMING 30 MIN...

1. Introduction to Haiti
2. Research set-up
3. Endogenous manufacturing
4. Optimal location manufacturing
5. Planning strategy
6. Conclusions
IN THE COMING 30 MIN...

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DECLINE OF LOCAL PRODUCTION

Haitian rice consumption
(Weisbrot et al., 2010)

Imported
Domestic

Ronald de Hommel, 2008
PORT AU PRINCE: GROWTH AND CONCENTRATION

Population Port au Prince (27%)

Population other parts

(US airforce, 2010)
DEFORESTATION AND EROSION

(James Blair, 1987)
LITTLE PARTICIPATION

(Andrew Yoon, 2006)
AIM:

Propose an inclusive method for spatial planning, which is capable of integrating the short-term goals of igniting the stagnated reconstruction process and promoting long-term sustainable development by increasing economic resilience.
ELEMENST OF HYPOTHESIS

- Integrated research
- Theoretical framework

Hypothesis
INTEGRATED RESEARCH

Integrated research

Theoretical framework

Hypothesis
LIFE CYCLE OF BUILDING MATERIALS

| Extraction | Manufacturing | Use | Disposal |

(Based on: van den Dobbelsteen, 2004)
LIFE CYCLE OF BUILDING MATERIALS

Extraction → Manufacturing → Use → Disposal → Extraction

Based on: van den Dobbelsteen, 2004
LIFE CYCLE OF BUILDING MATERIALS

- Extraction
- Manufacturing
- Use
- Disposal

(R. de Ruiter)

Carrying capacity landscape

(L. Smits)

Urban planning

(Based on: van den Dobbelsteen, 2004)
LIFE CYCLE OF BUILDING MATERIALS

Extraction → Manufacturing → Use → Disposal → Extraction

R. de Ruiter
Carrying capacity landscape

L. Smits
Urban planning

E. de Visser
Design building

(Based on: van den Dobbelsteen, 2004)
RELEVANCE OF BUILDING MATERIALS

(Andrew Yoon, 2006)
THEORETICAL FRAMEWORK

- Integrated research
- Theoretical framework

Hypothesis
SUSTAINABLE DEVELOPMENT

“The opportunity for individuals to fulfill their potential” (UN, 2009)
POVERTY ALLEVIATION
ECONOMIC DEVELOPMENT

Economic growth
Equity
Environment

(Image source: flickr.com/photos/innovaticlab)
ECONOMIC RESILIENCE

Economic resilience (Barrito, 2008):

“The policy-induced ability of an economy to recover from or adjust to the negative impacts of adverse exogenous shocks”
ECONOMIC ALTERNATIVES

NATURAL RESOURCES

- economy

ECONOMY

- natural resources

(Image source: fastcodesign.com)
Urban metabolism (Wolman, 1965):

“[the city as a] living organism that takes in energy and materials, transforms them through metabolic processes into usable goods and services, and excretes waste”
SPATIAL PLANNING METHODS

Strategic vision
(source: webarchive.nationalarchives.gov.uk)

Famous masterplan
(Source: stadsarchief.amsterdam.nl)
PARTICIPATION

Social capital

(Source: By author)

(Image source: flickr.com/IFRC)
HYPOTHESIS:

The aim can be achieved by introducing principles of strategic and collaborative spatial planning, using the introduction of endogenous manufacturing facilities as a strategic focus.

AIM:

integrative and inclusive method for spatial planning, integrating short and long term goals promoting sustainable development by increasing economic resilience.
RESEARCH QUESTIONS:

1. Examples of endogenous manufacturing?

2. Ideal locations for manufacturing facilities?

3. Use of introducing manufacturing in urban planning?

4. Include more stakeholders in planning process?
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RESEARCH QUESTION 1

Integrated research

Material flow analysis

2 Case studies
RQ1: PLASTIC ROOF TILES

(Image sources: author and Tyldesly, 2009)
RQ1: RICE-WASTE PANELS

(Image sources: e-ehitus.ee and stramit.co.uk)
RQ1: SCHEMATIC DESIGNS

Conventional house  Cordaid shelter  Plastic roof tiles  Rice-waste panels
## RQ1: TESTING ON INDICATORS

<table>
<thead>
<tr>
<th>House type</th>
<th>Costs in dollar</th>
<th>Jobs per house</th>
<th>Embodied CO2 (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional house</td>
<td>1224,-</td>
<td>2.3</td>
<td>11,100</td>
</tr>
<tr>
<td>Cordaid T-shelter</td>
<td>3500,-</td>
<td>9.7</td>
<td>2,507</td>
</tr>
<tr>
<td>Roof out of recycled plastic</td>
<td>2684,-</td>
<td>8.8</td>
<td>9,969</td>
</tr>
<tr>
<td>Walls out of rice-straw panels</td>
<td>1658,-</td>
<td>5.2</td>
<td>-8,486</td>
</tr>
</tbody>
</table>
RQ2: OPTIMAL LOCATION MANUFACTURING

Hierarchical indicators:

- All locations:
  - Location A
  - Location B
  - Location C
  - Etc.

- Mobility:

- Availability of employees:

- Availability of sustainable energy:

- Landscape restrictions:

- Remaining areas:
INDICATOR 1: MOBILITY

1. Hierarchy
2. Public transport
3. Lanes Pavement
4. Classified connectivity

Low total score
Height total score
INDICATOR 2: EMPLOYEE AVAILABILITY

1. Population density
2. Walking distance buffer

- Low population density
- High population density
- Selected route
INDICATOR 3: SUSTAINABLE ENERGY

1. Hydropower potential
2. Solar energy potential
3. Wind energy potential

10 km range hydro power possibility
Selected route
INDICATOR 4: LANDSCAPE RESTRICTIONS

1. Too agricultural
2. Too mountainous
3. Too urban

Limitations due to landscape
Areas suitable to introduce manufacturing
RESULT: SUITABLE AREAS
RQ2: PLANNING MEHTOD

Spatial analysis → Shared understandings → Vision → Strategic spatial interventions → Evaluation

Planning strategy
POPULATION GROWTH

- 1.5 Million, 1980
- 2.7 Million, 2009
- 4 Million, 2020

1.5 Million, 1980

2.7 Million, 2009

4 Million, 2020
SPRAWL

2002 (google maps)

2006 (google maps)

2010 (google maps)
NATURAL HAZARDS

(www.eqclearinghouse.org)
(www.myowneyes.org)
INFRASTRUCTURE

Distances in **kilometre**

- 250 km

Distances in **travel time**

- 11 hours
VISION...
SAMPLE 1: LEOGANE

Population growth
Density, services, land use

Risk of natural hazards:
Floods and landslides

Mobility:
Road characteristics

Manufacturing:
Possible locations
SAMPLE 1: LEOGANE

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Population growth
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Mobility:
Road characteristics

Manufacturing:
Possible locations
SAMPLE 1: LEOGANE

Conclusion of evaluation
SAMPLE 1: LEOGANE

Possible spatial outcome resulting from the evaluation
OTHER SAMPLES

Carrefour (sample 2)

Centre Ville (sample 3)

Croix-des-bouquets (sample 4)
**ELEMENT ONE:**

Conflicting land-use regional scale

- Population density
- Urban centres
- Open space

- Landslide risk
- Flood risk

- Current road structure
- Road hierarchy

---

**REGIONAL VISION**

1. Conflicting land-use regional scale
2. Local possible spatial interventions
3. Guiding principles
ELEMENT TWO:
Possible local spatial interventions

1. Conflicting land-use regional scale
2. Local possible spatial interventions
3. Guiding principles

REGIONAL VISION
ELEMENT THREE:
Guidelines for extrapolation

1. Conflicting land-use regional scale
2. Local possible spatial interventions
3. Guiding principles

REGIONAL VISION
CENTRAL PLANNING AGENCY

- International partners
- Municipal agencies
- Local residents

Planning strategy

Leogane area

Cabaret area

Planning agency

Leogane area

Central Planning Agency

Planning agency

Cabaret area

Ministries

Municipal agencies

International partners

Local residents

Local residents

Metropolitan agency PaP
STAKEHOLDERS

(Image: By author (2012), Based on (Forsman, 2009))
LOCAL PLANNING AGENCY

Manufacturer

Neighbourhood B

Neighbourhood A

Local planning agency

Initiating NGO

Local government
COLLABORATIVE PLANNING: LEOGANE

(Source: Nick Hongood (2011), Janney Joy (2012), IFRC.flickr.com)
**EVALUATION**

<table>
<thead>
<tr>
<th>Evaluation indicators per theoretical framework element</th>
<th>Evaluation indicators per theoretical framework element</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Envisioned spatial outcome</strong></td>
<td>Does the envisioned spatial outcomes steer urban development away from areas with high risk of natural hazards?</td>
</tr>
<tr>
<td></td>
<td>Does the envisioned spatial outcomes contribute to a less peripheral position?</td>
</tr>
<tr>
<td></td>
<td>Is the envisioned spatial outcomes a network of infrastructural distributed economies?</td>
</tr>
<tr>
<td><strong>Planning method</strong></td>
<td>Does the planning process provide a framework for foreign partners to fit their projects?</td>
</tr>
<tr>
<td></td>
<td>Is the long term consideration in the planning process?</td>
</tr>
<tr>
<td></td>
<td>Is there room for research and exploration, instead of deterministic plans?</td>
</tr>
<tr>
<td></td>
<td>Are there rules and regulations for manufacturing facilities?</td>
</tr>
<tr>
<td></td>
<td>Does the proposed structure not depend heavily on non-present institutions?</td>
</tr>
<tr>
<td></td>
<td>Does the proposed planning structure recognize the role of social capital in Haiti’s society? (The substitution of the formal institutions by social capital structures)</td>
</tr>
<tr>
<td></td>
<td>Is the proposed planning structure likely to stimulate the capacity building in local institutions?</td>
</tr>
<tr>
<td><strong>Manufacturing process</strong></td>
<td>Does the proposed manufacturing facility contribute to the depletion of finite resources?</td>
</tr>
<tr>
<td></td>
<td>Does the proposed manufacturing facility contribute to an equal distribution of wealth?</td>
</tr>
<tr>
<td></td>
<td>Does the proposed manufacturing facility contribute to global warming by emitting CO2?</td>
</tr>
<tr>
<td></td>
<td>Does the proposed manufacturing facility generate voluminous or toxic waste streams?</td>
</tr>
<tr>
<td></td>
<td>Does the proposed manufacturing facility contribute to using less material?</td>
</tr>
<tr>
<td></td>
<td>Does the proposed manufacturing facility close loops of material flows?</td>
</tr>
<tr>
<td></td>
<td>Does the proposed manufacturing facility change the source/direction of material flows?</td>
</tr>
<tr>
<td></td>
<td>Does the proposed manufacturing facility increase the level of export variety?</td>
</tr>
<tr>
<td></td>
<td>Does the proposed manufacturing facility increase the level of variety of market destinations?</td>
</tr>
<tr>
<td></td>
<td>Is the proposed manufacturing facility likely to improve relevant social indicators that are important in economic vulnerability?</td>
</tr>
<tr>
<td></td>
<td>Is the proposed manufacturing facility likely to reduce the Nett food import ratio?</td>
</tr>
<tr>
<td></td>
<td>Is the amount of national saving likely to grow due to the introduction of this manufacturing facility?</td>
</tr>
<tr>
<td></td>
<td>Is the economic proposal embedded in a social and environmental context?</td>
</tr>
<tr>
<td></td>
<td>Are there negative elements of the proposed manufacturing facilities that are externalised to harm other people than the ones benefitting from the production?</td>
</tr>
<tr>
<td></td>
<td>Is the consumption of more ‘material’ discouraged by the use of the products of the proposed manufacturing?</td>
</tr>
<tr>
<td></td>
<td>Are there unrealistic expectations regarding the benefits of future technology in the proposed manufacturing process?</td>
</tr>
<tr>
<td></td>
<td>Are the benefits of the proposed manufacturing facilities not based on large or increasing size of manufacturing facilities?</td>
</tr>
</tbody>
</table>
CONCLUSION: ENDogenous MANUFACTURING

Environmental Sustainability

Economic Sustainability

Social Sustainability

Closing of material loops

Changed direction flow: less CO2

Increased economic resilience

Possibilities for export

Panels needed for densification: 262,262 m²
Production capacity: 3,586,018 m²
Possible export: 3,323,756 m²

Creation of local jobs
CONCLUSION: PLANNING METHOD

Integrated elements

Possible benefits

Short term goals
Long term goals
Stakeholders

Capacity building local formal institutions
Economic resilience
Decreased dependence
Environmental sustainability
Democratisation?
CELEBRATORY DRINKS!

Tomorrow, Saturday April 21st.
Sint Jansbrug; Oude Delft 50-52; Achterzaal;
From 21:00 onwards
# Introduction to Haiti Manufacturing

laurasmits@gmail.com  
April 20, 2012

## Research set-up

**Optimal location**

### Extra

**Calculations Case Studies: Blocks**

<table>
<thead>
<tr>
<th>Material</th>
<th>Specification</th>
<th>Size</th>
<th>Amount</th>
<th>Unit</th>
<th>M3 of house</th>
<th>M3 of material/M3 of house</th>
<th>Density material (kg/M3)</th>
<th>Kg material/M3 of house</th>
<th>Embodied energy material (MJ/kg)</th>
<th>Embodied carbon material (CO2/kg)</th>
<th>Embodied carbon (kg/M3 house)</th>
<th>Import distance (km)</th>
<th>Mode of transport</th>
<th>CO2 emissions (kgCO2/tonne-km)</th>
<th>Kg CO2 per m3 of house to transport</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete blocks</td>
<td>Most common concrete blocks in Haiti</td>
<td>0.39 x 0.2 x 0.14</td>
<td>1022.0</td>
<td>pcs</td>
<td>18.9</td>
<td>33.2</td>
<td>3.9</td>
<td>1204.0</td>
<td>305.0</td>
<td>0.6</td>
<td>92.1</td>
<td>0.6</td>
<td>186.0</td>
<td>0.014</td>
<td>0.6</td>
<td>Source: 2,5</td>
</tr>
<tr>
<td>Concrete for columns</td>
<td>0.2 x 0.2 x 0.2</td>
<td>4.0</td>
<td>pcs</td>
<td>0.6</td>
<td>33.2</td>
<td>0.0</td>
<td>1600.0</td>
<td>14.5</td>
<td>1.1</td>
<td>16.1</td>
<td>0.2</td>
<td>2.3</td>
<td>18% weight from mexico</td>
<td>0.014</td>
<td>0.0</td>
<td>Source: 1</td>
</tr>
<tr>
<td>Concrete for floor</td>
<td>0.5 x 3.0 x 0.3</td>
<td>1.0</td>
<td>pcs</td>
<td>3.6</td>
<td>33.2</td>
<td>0.5</td>
<td>1650.0</td>
<td>137.5</td>
<td>1.1</td>
<td>153.6</td>
<td>0.2</td>
<td>21.9</td>
<td>18% weight from mexico</td>
<td>0.014</td>
<td>0.4</td>
<td>Source: 1</td>
</tr>
<tr>
<td>Concrete for roof</td>
<td>0.5 x 3.3 x 0.2</td>
<td>1.0</td>
<td>pcs</td>
<td>4.4</td>
<td>33.2</td>
<td>0.1</td>
<td>1600.0</td>
<td>166.2</td>
<td>1.1</td>
<td>184.5</td>
<td>0.2</td>
<td>26.0</td>
<td>18% weight from mexico</td>
<td>0.014</td>
<td>0.5</td>
<td>Source: 1</td>
</tr>
<tr>
<td>Mortar</td>
<td>calculated per block</td>
<td>2100.0 litres</td>
<td>litres</td>
<td>2.1</td>
<td>33.2</td>
<td>0.0</td>
<td>1900.0</td>
<td>92.4</td>
<td>1.2</td>
<td>111.8</td>
<td>0.2</td>
<td>16.3</td>
<td>18% weight from mexico</td>
<td>0.014</td>
<td>0.4</td>
<td>Source: 1</td>
</tr>
</tbody>
</table>

**Total/M3**

| Material             |                      | 657.1                     |                    |                  |                          |                            |                          |                                |

**Total per house**

| Material             |                      | 283.0                     |                    |                  |                          |                            |                          |                                |

### Labor costs

| Foundation          | 48.0 working hours   | 0.8                      | 37.4               | Source: 3 |
| Roof                | 48.0 working hours   | 0.8                      | 37.4               | Estimate |
| Columns             | 48.0 working hours   | 0.8                      | 37.4               | Estimate |
| Laying the blocks   | 47.7 working hours   | 0.8                      | 37.4               | Estimate |

### Job intensity

<table>
<thead>
<tr>
<th>System</th>
<th>Jobs</th>
<th>Time per job</th>
<th>Number of units</th>
<th>Per unit</th>
<th>Source</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block making</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>0.0</td>
<td>Interview local building contractor</td>
<td>Nobody gets paid to do this, volunteers...</td>
</tr>
<tr>
<td>Block laying</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>0.0</td>
<td>Estimate</td>
<td>Most people lay their own blocks...</td>
</tr>
<tr>
<td>Concrete pouring roof</td>
<td>5</td>
<td>0/7</td>
<td>1</td>
<td>0.7</td>
<td>All hands volunteers</td>
<td>Numbers were for a school, house is smaller... (all hands: 60, one day, school)</td>
</tr>
<tr>
<td>Concrete pouring foundation</td>
<td>5</td>
<td>0/7</td>
<td>1</td>
<td>0.7</td>
<td>All hands volunteers</td>
<td>Numbers were for a school, house is smaller... (all hands: 60, one day, school)</td>
</tr>
<tr>
<td>Concrete pouring columns</td>
<td>5</td>
<td>0/7</td>
<td>1</td>
<td>0.7</td>
<td>All hands volunteers</td>
<td>Numbers were for a school, house is smaller... (all hands: 60, one day, school)</td>
</tr>
<tr>
<td>Transport of bulk materials</td>
<td>1</td>
<td>0/2</td>
<td>1</td>
<td>0.1</td>
<td>Estimate</td>
<td>One truck driver working one day to deliver all materials...</td>
</tr>
</tbody>
</table>

**Total cost for the house**

<table>
<thead>
<tr>
<th>Material</th>
<th>Cost per unit</th>
<th>Total cost per house</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete blocks</td>
<td>502.0</td>
<td>283.0</td>
</tr>
<tr>
<td>Concrete for columns</td>
<td>48.0</td>
<td>28.3</td>
</tr>
<tr>
<td>Cement</td>
<td>48.0</td>
<td>28.3</td>
</tr>
<tr>
<td>Aggregate</td>
<td>48.0</td>
<td>28.3</td>
</tr>
<tr>
<td>Sand</td>
<td>48.0</td>
<td>28.3</td>
</tr>
<tr>
<td>Water</td>
<td>48.0</td>
<td>28.3</td>
</tr>
<tr>
<td>Concrete for roof</td>
<td>48.0</td>
<td>28.3</td>
</tr>
<tr>
<td>Foundation</td>
<td>48.0</td>
<td>28.3</td>
</tr>
<tr>
<td>Total</td>
<td>239.7</td>
<td>131.0</td>
</tr>
</tbody>
</table>

**TOTAL PER HOUSE**

<table>
<thead>
<tr>
<th>Material</th>
<th>Cost per unit</th>
<th>Total cost per house</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>657.1</td>
<td>362.4</td>
</tr>
</tbody>
</table>

**Material**

- **Concrete blocks:** Most common concrete blocks in Haiti
- **Concrete for columns:** 0.2 x 0.2 x 0.2
- **Concrete for floor:** 0.5 x 3.0 x 0.3
- **Concrete for roof:** 0.5 x 3.3 x 0.2
- **Mortar:** calculated per block

**Material specification**

- **Size:** Width x Depth x Height
- **Amount:** Quantity of material
- **Unit:** Unit of measurement
- **Density material (kg/M3):** Density of material
- **Kg material/M3 of house:** Kilograms of material per cubic meter of house

**Costs**

<table>
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<td>28.3</td>
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<td>48.0</td>
<td>28.3</td>
</tr>
<tr>
<td>Total</td>
<td>657.1</td>
<td>362.4</td>
</tr>
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</table>
## Calculations Case Studies: Shelter

### Embodied Carbon

<table>
<thead>
<tr>
<th>Material</th>
<th>Specification</th>
<th>Size</th>
<th>Amount</th>
<th>Unit</th>
<th>MJ</th>
<th>MJ/m^3 House</th>
<th>MJ/m^3 of All</th>
<th>Density (kg/m^3)</th>
<th>Embodied energy (MJ/kg)</th>
<th>Embodied carbon (kg CO2/M^3)</th>
<th>Ecoinvent 4 parametric scenario</th>
<th>Imported from</th>
<th>Import distance (km)</th>
<th>Mode of transport</th>
<th>CO2  per m^3 for transport</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood</td>
<td>Southern Yellow Pine, ACO Pressure treated #2, Prime</td>
<td>2x2</td>
<td>33.0</td>
<td>bbl</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Wood</td>
<td>Idem</td>
<td>2x4</td>
<td>647.0</td>
<td>bbl</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Wood</td>
<td>Idem</td>
<td>1x4</td>
<td>45.0</td>
<td>bbl</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Wood</td>
<td>Idem</td>
<td>1x6</td>
<td>191.0</td>
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</tr>
<tr>
<td>Wood total</td>
<td>Soft wood</td>
<td></td>
<td>941.0</td>
<td>bbl</td>
<td>2.2</td>
<td>40.7</td>
<td>0.0</td>
<td>510.0</td>
<td>23.7</td>
<td>74</td>
<td>175.6</td>
<td>0.5</td>
<td>10.7</td>
<td>USA (New York)</td>
<td>2400.0</td>
<td>Larger container vessel</td>
</tr>
<tr>
<td>Plywood</td>
<td>Pressure Treated Exterior grade CD Plywood</td>
<td>5” by 4” by 0.5”</td>
<td>4.0</td>
<td>Sheets</td>
<td>0.3</td>
<td>40.7</td>
<td>0.0</td>
<td>540.0</td>
<td>0.6</td>
<td>15.0</td>
<td>0.6</td>
<td>0.3</td>
<td>USA (New York)</td>
<td>2400.0</td>
<td>Larger container vessel</td>
<td>0.015</td>
</tr>
<tr>
<td>Corrugated metal</td>
<td>Pre-painted Alumin</td>
<td>20’</td>
<td>106.7</td>
<td>0.60</td>
<td>0.0</td>
<td>47.7</td>
<td>0.0</td>
<td>3750.0</td>
<td>0.0</td>
<td>113.1</td>
<td>1.5</td>
<td>6.0</td>
<td>0.1</td>
<td>Mexico</td>
<td>1300.0</td>
<td>Small container vessel</td>
</tr>
<tr>
<td>Metal</td>
<td>1.5” wide iron bars of 3/16” thickness x 4” = 5 anchors per 20’ bar</td>
<td>Anchors</td>
<td>6.0</td>
<td>pcs</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Metal</td>
<td>2” wide iron bars of 3/16” thickness x 4” = 5 anchors per 20’ bar</td>
<td>Anchors</td>
<td>6.0</td>
<td>pcs</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Metal</td>
<td>7” Hurricane Straps</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Concrete</td>
<td>Pile (10 cm thick)</td>
<td>4 x 4</td>
<td>1.8</td>
<td>m^3</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Concrete</td>
<td>Foundation (10 times)</td>
<td>0.5 x 0.5 x 0.6</td>
<td>1.5</td>
<td>m^3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concrete total</td>
<td></td>
<td></td>
<td>3.3</td>
<td>m^3</td>
<td>3.3</td>
<td>40.7</td>
<td>0.1</td>
<td>1650.0</td>
<td>114.2</td>
<td>1.1</td>
<td>128.7</td>
<td>0.2</td>
<td>18.2</td>
<td>18% weight from Mexico</td>
<td>1300.0</td>
<td>Small container vessel</td>
</tr>
<tr>
<td>Mortar</td>
<td>Rendering Walls, 10 cm thick</td>
<td>3.4</td>
<td>m^3</td>
<td>3.4</td>
<td>40.7</td>
<td>0.1</td>
<td>1600.0</td>
<td>113.7</td>
<td>1.2</td>
<td>137.6</td>
<td>0.2</td>
<td>20.1</td>
<td>25% weight from Mexico</td>
<td>1300.0</td>
<td>Small container vessel</td>
<td>0.014</td>
</tr>
<tr>
<td>Steel mesh</td>
<td>Walls, 10 cm thick</td>
<td>33.9</td>
<td>m^2</td>
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<tr>
<td><strong>TOTAL</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL HOUSE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Costs

<table>
<thead>
<tr>
<th>Material</th>
<th>Amount</th>
<th>Ratio</th>
<th>Contractor</th>
<th>Total costs</th>
<th>Contractor</th>
<th>Full time ratio</th>
<th>Total cost</th>
<th>Source</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not specified</td>
<td>No specification</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL PER HOUSE</strong></td>
<td></td>
<td></td>
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<td></td>
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</table>

### Job Intensity

<table>
<thead>
<tr>
<th>Source</th>
<th>Sector</th>
<th>Code</th>
<th>Full time</th>
<th>Full time ratio</th>
<th>Cost/Full time</th>
<th>Source</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordination cordaid</td>
<td>1.0</td>
<td>1.0</td>
<td>1800.0</td>
<td>0.0</td>
<td>Own observations</td>
<td>Observations for the septieme area</td>
<td></td>
</tr>
<tr>
<td>Maxima SA</td>
<td>250.0</td>
<td>1.0</td>
<td>1850.0</td>
<td>0.1</td>
<td>maxima SA website</td>
<td>Not clear whether all people work only on the cordaid shelters.</td>
<td></td>
</tr>
<tr>
<td>Local contractors per house</td>
<td>1.0</td>
<td>1.0</td>
<td>10.0</td>
<td>1.0</td>
<td>Estimate</td>
<td>Uclear how many people work for local contractors.</td>
<td></td>
</tr>
<tr>
<td>Construction on site</td>
<td>8.0</td>
<td>0.6</td>
<td>10.0</td>
<td>4.6</td>
<td>Cordaid Haiti</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL JOBS PER HOUSE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**Remarks**

1. Source: 1
2. Source: 2
3. Source: 3
4. Source: 4
5. Source: 5
6. Source: 6
### Calculations Case Studies: Plastic

#### Embedded Carbon

<table>
<thead>
<tr>
<th>Material</th>
<th>Specification</th>
<th>Size</th>
<th>Amount</th>
<th>Unit</th>
<th>M3 of house</th>
<th>M3 of material per M3 of house</th>
<th>Density (kg/M3)</th>
<th>Embodied energy (MJ/kg)</th>
<th>Embodied carbon (CO2/kg)</th>
<th>Embodied carbon (kg/M3 house)</th>
<th>Import distance</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete blocks</td>
<td>Most common concrete blocks in Haiti</td>
<td>0.39 x 0.2 x 0.14</td>
<td>1002.0</td>
<td>pcs</td>
<td>338.9</td>
<td>45.9</td>
<td>1204.0</td>
<td>240.4</td>
<td>172.5</td>
<td>11% weight from Mexico</td>
<td></td>
<td>Data for block from CHAMBERS, 2010; Mix Source R(Sand) (TOTTEN, 2010)</td>
</tr>
<tr>
<td>Concrete for columns</td>
<td>0.2 x 0.2 x 0.4</td>
<td>4.0</td>
<td>pcs</td>
<td>0.4</td>
<td>45.9</td>
<td>0.2</td>
<td>1600.0</td>
<td>13.7</td>
<td>15.2</td>
<td>18% weight from Mexico</td>
<td></td>
<td>Source/4, HAMMOND and JONES, 2008, Cement import from Mexico</td>
</tr>
<tr>
<td>Concrete for floor</td>
<td>0.6 x 3 x 0.2</td>
<td>1.0</td>
<td>pcs</td>
<td>3.6</td>
<td>45.9</td>
<td>1.0</td>
<td>1600.0</td>
<td>12.4</td>
<td>143.6</td>
<td>18% weight from Mexico</td>
<td></td>
<td>Source/4, HAMMOND and JONES, 2008, Cement import from Mexico</td>
</tr>
<tr>
<td>Mortar</td>
<td>calculated per block</td>
<td>2100.0</td>
<td>litres</td>
<td>3.1</td>
<td>45.9</td>
<td>0.0</td>
<td>1900.0</td>
<td>86.9</td>
<td>105.2</td>
<td>25% weight from Mexico</td>
<td></td>
<td>Density source: HAMMOND and JONES, 2010 (sand) Cement import from Mexico</td>
</tr>
<tr>
<td>Wood for roof construction</td>
<td>Soft wood</td>
<td>0.05 x 0.05</td>
<td>2.2</td>
<td>45.9</td>
<td>0.0</td>
<td>510.0</td>
<td>USA (new york)</td>
<td>17.8</td>
<td>0.5</td>
<td>USA (new york)</td>
<td></td>
<td>Remarks: Plastic from recycled plastic, britanica</td>
</tr>
<tr>
<td>Roof tiles</td>
<td>From recycled plastic, britanica</td>
<td>315 mm x 405 mm</td>
<td>238.0</td>
<td>pcs</td>
<td>0.4</td>
<td>45.9</td>
<td>0.0</td>
<td>1500.0</td>
<td>13.5</td>
<td>0.1</td>
<td>USA (new york)</td>
<td></td>
</tr>
<tr>
<td>Mortar</td>
<td>calculated per block</td>
<td>2100.0</td>
<td>litres</td>
<td>3.1</td>
<td>45.9</td>
<td>0.0</td>
<td>1900.0</td>
<td>86.9</td>
<td>105.2</td>
<td>25% weight from Mexico</td>
<td></td>
<td>Density source: HAMMOND and JONES, 2010 (sand) Cement import from Mexico</td>
</tr>
<tr>
<td>Wood for roof construction</td>
<td>Soft wood</td>
<td>0.05 x 0.05</td>
<td>2.2</td>
<td>45.9</td>
<td>0.0</td>
<td>510.0</td>
<td>USA (new york)</td>
<td>17.8</td>
<td>0.5</td>
<td>USA (new york)</td>
<td></td>
<td>Remarks: Plastic from recycled plastic, britanica</td>
</tr>
<tr>
<td>Roof tiles</td>
<td>From recycled plastic, britanica</td>
<td>315 mm x 405 mm</td>
<td>238.0</td>
<td>pcs</td>
<td>0.4</td>
<td>45.9</td>
<td>0.0</td>
<td>1500.0</td>
<td>13.5</td>
<td>0.1</td>
<td>USA (new york)</td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL M3**

<table>
<thead>
<tr>
<th>Material</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>793.68</td>
<td>TOTAL M3: 793.68</td>
<td></td>
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</tr>
</tbody>
</table>

**TOTAL PER HOUSE**

| Material                      |                             |             |       |       |             |                             |                   |                      | 19983.11               | TOTAL PER HOUSE: 19983.11                                     |                |                          |

#### Costs

| Material                      |                             |             |       |       |             |                             |                   |                      | 224,44                  | TOTAL JOB INTENSITY: 224,44                                    |                |                          |

| Material                      |                             |             |       |       |             |                             |                   |                      | 3,155                  | JOB INTENSITY: 3,155                             |                |                          |

**Labour costs**

<table>
<thead>
<tr>
<th>Labour costs</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Labour costs: 3,155</th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation</td>
<td>48.0 working hours</td>
<td>0.8</td>
<td>37.4</td>
<td>Source: 3</td>
<td></td>
<td></td>
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<td>Labour costs: 3,155</td>
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<td></td>
</tr>
<tr>
<td>Columns</td>
<td>48.0 working hours</td>
<td>0.8</td>
<td>37.4</td>
<td>Estimate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Labour costs: 3,155</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laying the blocks</td>
<td>48.0 working hours</td>
<td>0.8</td>
<td>37.4</td>
<td>Estimate</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>Labour costs: 3,155</td>
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</tr>
<tr>
<td>Laying the roof tiles</td>
<td>32.0 working hours</td>
<td>0.8</td>
<td>25.0</td>
<td>Estimate</td>
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<td></td>
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<td>Labour costs: 3,155</td>
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</tbody>
</table>
# Calculations Case Studies

## Embodied Carbon

<table>
<thead>
<tr>
<th>Material</th>
<th>Specification</th>
<th>Size</th>
<th>Unit</th>
<th>M3</th>
<th>M3 of house</th>
<th>Density (Kg/M3)</th>
<th>Kg/M3 per M3 of house</th>
<th>Embodied energy (MJ/kg)</th>
<th>Embodied carbon (kg/M3 house)</th>
<th>Embodied carbon (kg/M3 house)</th>
<th>Imported wood</th>
<th>Imported transport</th>
<th>Cost of embodied carbon (€/M3)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete for floor</td>
<td>Concrete for floor</td>
<td>6 x 3 x 0,2</td>
<td>m3</td>
<td>1,0</td>
<td>3,60</td>
<td>58,70 0,09</td>
<td>1650,06</td>
<td>153,49</td>
<td>1,11</td>
<td>120,37</td>
<td>0,16</td>
<td>24,40</td>
<td>18% weight from Mexico</td>
<td>Source: 3. Embedded energy = 1</td>
</tr>
<tr>
<td>Rice-straw panels walls</td>
<td>Rice-straw panels</td>
<td>2,7 * 3 * 0,11</td>
<td>m2</td>
<td>40,8</td>
<td>4,49</td>
<td>58,70 0,12</td>
<td>380,00</td>
<td>44,07</td>
<td>0,24</td>
<td>10,58</td>
<td>2,86</td>
<td>-126,04</td>
<td>Local</td>
<td>n.a.</td>
</tr>
<tr>
<td>Rice-straw panels roof</td>
<td>Rice-straw panels</td>
<td>2,7 * 3 * 0,11</td>
<td>m2</td>
<td>38,4</td>
<td>4,22</td>
<td>58,70 0,11</td>
<td>320,00</td>
<td>41,48</td>
<td>0,24</td>
<td>9,95</td>
<td>2,86</td>
<td>-118,62</td>
<td>Local</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

| TOTAL M3                  | TOTAL M3       | 190,90 | 190,90 | 73 | 87,93       |                  |                      |                        |                          |                            |                          |                      |                                |        |

## Costs

<table>
<thead>
<tr>
<th>Material</th>
<th>Amount</th>
<th>Rate</th>
<th>Cost per unit</th>
<th>Total cost</th>
<th>Cement density</th>
<th>Total M3</th>
<th>Kg</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete for floor</td>
<td>3,6</td>
<td>1,0</td>
<td>2</td>
<td>1,0</td>
<td>164,8</td>
<td>1860,0</td>
<td>1030,2</td>
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</tr>
<tr>
<td>Aggregate</td>
<td>1,7</td>
<td>3,0</td>
<td>0,2</td>
<td>0,2</td>
<td>152,0</td>
<td>1100,0</td>
<td>1087,2</td>
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<tr>
<td>Sand</td>
<td>0,8</td>
<td>1,5</td>
<td>0,2</td>
<td>0,2</td>
<td>152,0</td>
<td>1100,0</td>
<td>1087,2</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>0,6</td>
<td>0,5</td>
<td>0,2</td>
<td>0,2</td>
<td>152,0</td>
<td>1100,0</td>
<td>1087,2</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Material</th>
<th>Amount</th>
<th>Rate</th>
<th>Cost per unit</th>
<th>Total cost</th>
<th>Cement density</th>
<th>Total M3</th>
<th>Kg</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice-straw panels walls</td>
<td>40,8</td>
<td>4,49</td>
<td>0,2</td>
<td>0,2</td>
<td>152,0</td>
<td>1100,0</td>
<td>1087,2</td>
<td></td>
</tr>
<tr>
<td>Rice-straw panels roof</td>
<td>38,4</td>
<td>4,22</td>
<td>0,2</td>
<td>0,2</td>
<td>152,0</td>
<td>1100,0</td>
<td>1087,2</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Material</th>
<th>Amount</th>
<th>Rate</th>
<th>Cost per unit</th>
<th>Total cost</th>
<th>Cement density</th>
<th>Total M3</th>
<th>Kg</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood</td>
<td>100,0</td>
<td>1,0</td>
<td>1</td>
<td>1</td>
<td>1000,0</td>
<td>1000,0</td>
<td></td>
<td>Estimate</td>
</tr>
<tr>
<td>Rice-straw panels</td>
<td>79,2</td>
<td>4,6</td>
<td>344,3</td>
<td>Price per m2=4,6</td>
<td>Source: 4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Material</th>
<th>Amount</th>
<th>Rate</th>
<th>Cost per unit</th>
<th>Total cost</th>
<th>Cement density</th>
<th>Total M3</th>
<th>Kg</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation</td>
<td>48,0</td>
<td>0,8</td>
<td>0,2</td>
<td>0,8</td>
<td>37,4</td>
<td>480,0</td>
<td></td>
<td>Source: 4</td>
</tr>
<tr>
<td>Rice-straw panels</td>
<td>96,0</td>
<td>0,8</td>
<td>0,2</td>
<td>0,2</td>
<td>149,2</td>
<td>193,6</td>
<td></td>
<td>Estimate</td>
</tr>
</tbody>
</table>

| TOTAL M3       | TOTAL M3       | 73 | 87,93 |        |                |            |     |         |

## Job Intensity

<table>
<thead>
<tr>
<th>Task Description</th>
<th>Full time</th>
<th>Part time</th>
<th>None</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working in the rice-straw panel factory</td>
<td>0,2</td>
<td>0</td>
<td>0,0</td>
<td></td>
</tr>
<tr>
<td>Setting wooden frame</td>
<td>0,0</td>
<td>0</td>
<td>1,4</td>
<td>Interview Michiel Mollen</td>
</tr>
<tr>
<td>Setting the rice-straw panel</td>
<td>0,0</td>
<td>0</td>
<td>1,7</td>
<td>Estimate</td>
</tr>
<tr>
<td>Concrete pouring foundation</td>
<td>15,0</td>
<td>0,1</td>
<td>2,1</td>
<td>All hands volunteers (numbers for a school, house is smaller, all hands 60, one day, school)</td>
</tr>
<tr>
<td>Transportation of bulk materials</td>
<td>1,0</td>
<td>0,0</td>
<td>0,1</td>
<td>Estimate (one truck driver working one day to deliver all materials)</td>
</tr>
</tbody>
</table>

| TOTAL JOBS PER HOUSE                          |            | 0,4      |      |         |