

Data & Equation list DARKHAN-15 WSP1+  
Simulation Settings

**Time Start:** 0  
**Time Length:** 60  
**Time Step:** 1  
**Time Units:** Months  
**Algorithm:** RK1

Model VariablesActivity cost

**Value:** 800  
**Units:** Unitless

Bag price

**Value:** IfThenElse(Months()>[Donation], 50000\*0.005,0)  
**Units:** Unitless

Birth rate

**Value:** RandNormal((24.7/1000)/12, 0.0004)  
**Units:** Unitless

Bolsas comp

**Value:** 0.03\*[Composted waste]/2  
**Units:** Unitless

Bolsas recicl

**Value:** 0.15\*[Recycled waste]/20  
**Units:** Unitless

Children with respiratory diseases

**Value:** [Respiratory diseases]  
**Units:** Unitless

Children with respiratory diseases rate

**Value:** [Children with respiratory diseases]\*[Nº children]  
**Units:** Unitless

Cleaning service staff cost

**Value:** 11\*8\*5  
**Units:** Unitless

Coal

**Value:**  
 $0.85 \cdot \sin(2 \cdot \pi \cdot (\text{Months}() + 2) / 12) \cdot [\text{Min Coal}] + [\text{Max Coal}]$   
**Units:** Unitless

Collection frequency

**Value:** 30  
**Units:** Unitless

Composted waste rate EHH

**Value:** RandNormal(0.096, 0.003)  
**Units:** Unitless

Composted waste rate NEHH

**Value:** RandNormal(0.001,0.001)  
**Units:** Unitless

Days per month

**Value:** 30  
**Units:** Unitless

Death rate indoor air pollution

**Value:** RandNormal([Indoor air pollution effect on diseases]/12, 0.0000125)  
**Units:** Unitless

Deaths rate

**Value:** ([Other deaths]/12)+[Death rate indoor air pollution]  
**Units:** Unitless

Donation

**Value:** 24  
**Units:** Unitless

Education delay

**Value:** 5  
**Units:** Unitless

Facilities effect

**Value:** .53  
**Units:** Unitless

Filter delay

**Value:** 2  
**Units:** Unitless

Fuel cost

**Value:** 800  
**Units:** Unitless

Garbage trucks monthly cost

**Value:** 5\*8  
**Units:** Unitless

HH members

**Value:** RandNormal(4, 0.03)  
**Units:** Unitless

HH rate educated

**Value:**  
[Non-educated household NEHH]\*([Knowledge, incentive, facilities effect]+[Reeducation rate])

**Units:** Unitless

Households

**Value:** 2500

**Units:** Unitless

Incentive effect

**Value:** 0.37

**Units:** Unitless

Indoor air pollution

**Value:** [Coal]+[Burned waste effect]

**Units:** Unitless

Infraestructura G. Residuos

**Value:** IfThenElse([Waste management infrastructure budget]=0, 1, 0)

**Units:** Unitless

Initial education budget

**Value:** 38400

**Units:** Unitless

Knowledge, incentive, facilities effect

**Value:** RandNormal([Education effect]\*(1+[Facilities effect]+[Incentive effect]), 0.001)

**Units:** Unitless

KOICA budget

**Value:** [Education budget]+[Lighting infrastructure budget]+[Waste management infrastructure budget]

**Units:** Unitless

Max Coal

**Value:** 90

**Units:** Unitless

Min Coal

**Value:** 90

**Units:** Unitless

Monthly public budget

**Value:** 136700

**Units:** Unitless

NE-HH waste to floor rate

**Value:** RandNormal(0.25, 0.005)

**Units:** Unitless

Not sealed pit letrines effect

**Value:** 1

**Units:** Unitless

Nº activities

**Value:** 1.33  
**Units:** Unitless

Nº children

**Value:** 0.25\*[Population]  
**Units:** Unitless

Other deaths

**Value:** 6.4/1000  
**Units:** Unitless

Outdoor pollution

**Value:** 0.55\*[Indoor air pollution]  
**Units:** Unitless

Private wells quality of water

**Value:** 0.50  
**Units:** Unitless

Proportion of water consumed-private wells

**Value:** 0.2  
**Units:** Unitless

Rate of WASH diseases

**Value:** [WASH diseases]  
**Units:** Unitless

Reciclyng rate HEE

**Value:** IfThenElse([Infraestructura G. Residuos]=1, RandNormal(0.3, 0.01), 0)  
**Units:** Unitless

Reciclyng rate NHEE

**Value:** RandNormal(0.0015,0.001)  
**Units:** Unitless

Recycled storage monthly rent

**Value:** 1300  
**Units:** Unitless

Residuos quemados en estufa

**Value:**  
 $\text{Sin}(1.5 \cdot \pi \cdot (\text{Months}() + 6) / 12) \cdot [\text{Burned waste}] / 20 + [\text{Burned waste}] / 10$   
**Units:** Unitless

Savings

**Value:** [Bolsas comp]+[Bolsas recicl]  
**Units:** Unitless

Sick population attributable to WASH

**Value:** [Rate of WASH diseases]\*[Population]  
**Units:** Unitless

smooth inner pollution

**Value:** Delay3([Indoor air pollution], 12)  
**Units:** Unitless

smooth inner pollution 2

**Value:** Delay3([smooth inner pollution], 12)  
**Units:** Unitless

smooth inner pollution 3

**Value:** Delay3([smooth inner pollution 2], 12)  
**Units:** Unitless

Streets lights

**Value:** IfThenElse([Lighting infrastructure budget]=0, 1, 0)  
**Units:** Unitless

Used bags

**Value:** [Waste to garbage bin]/2  
**Units:** Unitless

Volunteers frequency

**Value:** 15  
**Units:** Unitless

Waste bags

**Value:** (([Burned waste]/50)+[Waste to garbage bin])/(RandNormal(5, 1))  
**Units:** Unitless

Waste burning rate EHH

**Value:** RandNormal(0.10, 0.001)  
**Units:** Unitless

Waste burning rate NEHH

**Value:** RandNormal(0.4,0.005)  
**Units:** Unitless

Waste generation EHH

**Value:** [Educated household EHH]\*[HH members]\*[Waste generation rate EHH]\*[Days per month]  
**Units:** Unitless

Waste generation NEHH

**Value:** [Waste generation rate NEHH]\*[Non-educated household NEHH]\*[HH members]\*[Days per month]  
**Units:** Unitless

Waste generation rate EHH

**Value:** RandNormal(0.50, 0.005)  
**Units:** Unitless

Waste generation rate NEHH

**Value:** RandNormal(0.6, .005)  
**Units:** Unitless

Waste taxes

**Value:** 0.07\*[Waste bags]  
**Units:** Unitless

Waste to bin rate EHH

**Value:** RandNormal(.50, 0.002)  
**Units:** Unitless

Waste to bin rate NEHH

**Value:** RandNormal(0.35, 0.015)  
**Units:** Unitless

Water consumed quality

**Value:** 1-[Water contamination]+[Proportion of water consumed-private wells]  
**Units:** Unitless

Water contamination

**Value:** [Private wells quality of water]+Delay([Waste on floor effect on water pollution], [Filter delay], 0)  
**Units:** Unitless

Model StocksEducated household EHH

**Initial Value:** 0  
**Non-Negative:** No  
**Units:** Unitless

Education budget

**Initial Value:** [Initial education budget]  
**Non-Negative:** Yes  
**Units:** Unitless

Intermediate waste

**Initial Value:** 0  
**Non-Negative:** Yes  
**Units:** Unitless

Lanfill

**Initial Value:** 0  
**Non-Negative:** Yes  
**Units:** Unitless

Lighting infrastructure budget

**Initial Value:** 2662000  
**Non-Negative:** Yes  
**Units:** Unitless

Non-educated household NEHH

**Initial Value:** [Households]  
**Non-Negative:** Yes  
**Units:** Unitless

Population

**Initial Value:**  
8647

**Non-Negative:** No  
**Units:** Unitless

Waste in bins

**Initial Value:** 0  
**Non-Negative:** Yes  
**Units:** Unitless

Waste management facilities funds

**Initial Value:** [Monthly public budget]  
**Non-Negative:** Yes  
**Units:** Unitless

Waste management infrastructure budget

**Initial Value:** 439000  
**Non-Negative:** Yes  
**Units:** Unitless

Waste on floor

**Initial Value:** 30000  
**Non-Negative:** Yes  
**Units:** Unitless

Model FlowsBirths

**Rate:** [Population]\*[Birth rate]  
**Alpha:** *None*  
**Omega:** Population  
**Positive Only:** Yes  
**Units:** Unitless

Burned waste

**Rate:** ([Waste burning rate NEHH]\*[Waste generation NEHH])+([Waste burning rate EHH]\*[Waste generation EHH])  
**Alpha:** Intermediate waste  
**Omega:** *None*  
**Positive Only:** Yes  
**Units:** Unitless

Composted waste

**Rate:** ([Composted waste rate EHH]\*[Waste generation EHH])+([Composted waste rate NEHH]\*[Waste generation NEHH])  
**Alpha:** Intermediate waste  
**Omega:** *None*  
**Positive Only:** Yes  
**Units:** Unitless

Deaths

**Rate:** [Deaths rate]\*[Population]

**Alpha:** Population  
**Omega:** *None*  
**Positive Only:** Yes  
**Units:** Unitless

#### Education activities expenses

**Rate:**  $\text{IfThenElse}([\text{N}^{\circ} \text{ activities}] * [\text{Activity cost}] > [\text{Education budget}], 0, [\text{N}^{\circ} \text{ activities}] * [\text{Activity cost}])$   
**Alpha:** Education budget  
**Omega:** *None*  
**Positive Only:** Yes  
**Units:** Unitless

#### Effective educated households - month

**Rate:**  
 $\text{IfThenElse}([\text{Non-educated household NEHH}] > 550, \text{Delay}([\text{HH rate educated}], [\text{Education delay}], 0), 0)$

**Alpha:** Non-educated household NEHH  
**Omega:** Educated household EHH  
**Positive Only:** Yes  
**Units:** Unitless

#### Garbage bags cost

**Rate:**  $\text{IfThenElse}([\text{Infraestructura G. Residuos}] = 1, ([\text{Bag price}]), 0)$   
**Alpha:** Waste management facilities funds  
**Omega:** *None*  
**Positive Only:** Yes  
**Units:** Unitless

#### Gasto Infraestr. gestión recursos

**Rate:** 87800  
**Alpha:** Waste management infrastructure budget  
**Omega:** *None*  
**Positive Only:** Yes  
**Units:** Unitless

#### Lighting costs

**Rate:**  $\text{IfThenElse}([\text{Streets lights}] = 1, 120000, 0)$   
**Alpha:** Waste management facilities funds  
**Omega:** *None*  
**Positive Only:** Yes  
**Units:** Unitless

#### Public local budget

**Rate:**  $\text{IfThenElse}([\text{Infraestructura G. Residuos}] = 1, [\text{Monthly public budget}] + [\text{Waste taxes}], 0)$   
**Alpha:** *None*  
**Omega:** Waste management facilities funds  
**Positive Only:** Yes  
**Units:** Unitless

#### Recycled waste

**Rate:**  $([\text{Reciclyng rate HEE}] * [\text{Waste generation EHH}]) + ([\text{Reciclyng rate NHEE}] * [\text{Waste generation NEHH}])$   
**Alpha:** Intermediate waste  
**Omega:** *None*  
**Positive Only:** Yes  
**Units:** Unitless



## Recycling costs

**Rate:** IfThenElse([Infraestructura G. Residuos]=1, [Recycled storage monthly rent]+[Fuel cost],0)

**Alpha:** Waste management facilities funds

**Omega:** None

**Positive Only:** Yes

**Units:** Unitless

## Rubbish collection 1

**Rate:** Pulse(1/5, [Waste in bins], 1/2, 1/[Collection frequency])

**Alpha:** Waste in bins

**Omega:** Lanfill

**Positive Only:** Yes

**Units:** Unitless

## Rubbish collection 2

**Rate:** Pulse(1/5, [Waste on floor], 1/2, 1/[Volunteers frequency])

**Alpha:** Waste on floor

**Omega:** Lanfill

**Positive Only:** Yes

**Units:** Unitless

## Rubbish collection cost

**Rate:** IfThenElse([Infraestructura G. Residuos]=1, [Collection frequency]\*([Garbage trucks monthly cost]+[Cleaning service staff cost]), 0)

**Alpha:** Waste management facilities funds

**Omega:** None

**Positive Only:** Yes

**Units:** Unitless

## Street lights installation expenses

**Rate:** IfThenElse([Lighting infrastructure budget]>0, 532400, 0)

**Alpha:** Lighting infrastructure budget

**Omega:** None

**Positive Only:** Yes

**Units:** Unitless

## Total generation waste

**Rate:** [Waste generation NEHH]+[Waste generation EHH]

**Alpha:** None

**Omega:** Intermediate waste

**Positive Only:** Yes

**Units:** Unitless

## Waste to floor

**Rate:** IfThenElse([Collection frequency]>10, [Waste generation NEHH]\*[NE-HH waste to floor rate], [Intermediate waste])

**Alpha:** Intermediate waste

**Omega:** Waste on floor

**Positive Only:** Yes

**Units:** Unitless

## Waste to garbage bin

**Rate:**

IfThenElse([Collection frequency]>10, ([Waste generation NEHH]\*[Waste to bin rate NEHH])+([Waste generation EHH]\*[Waste to bin rate EHH]), 0\*15+ ([Waste generation NEHH]\*[Waste to bin rate NEHH])+([Waste generation EHH]\*[Waste to bin rate EHH]))

**Alpha:** Intermediate waste  
**Omega:** Waste in bins  
**Positive Only:** Yes  
**Units:** Unitless

Model ConvertersBurned waste effect

**Data:** 10000,10; 15000,20; 20000,30; 30000,40; 40000,50; 50000,60; 60000,70  
**Source:** Residuos quemados en estufa  
**Interpolation:** Linear  
**Units:** Unitless

Education effect

**Data:** 400,0.001; 600,0.002; 800,0.005; 1000,0.01  
**Source:** Education activities expenses  
**Interpolation:** Linear  
**Units:** Unitless

Indoor air pollution effect on diseases

**Data:** 20,0.0002; 60,0.0003; 100,0.0004; 140,0.0005; 180,0.0006  
**Source:** smooth inner pollution 3  
**Interpolation:** Linear  
**Units:** Unitless

Reeducation rate

**Data:** 50,0.0001; 200,0.0005; 400,0.001; 600,0.01; 800,0.05; 1000,0.08; 1500,0.11  
**Source:** Educated household EHH  
**Interpolation:** Linear  
**Units:** Unitless

Respiratory diseases

**Data:** 80,0.2; 100,0.36; 150,0.41  
**Source:** smooth inner pollution 3  
**Interpolation:** Linear  
**Units:** Unitless

WASH diseases

**Data:** 0.3,0.2; 0.4,0.04; 0.5,0.019; 0.6,0.01; 0.7,0.001  
**Source:** Water consumed quality  
**Interpolation:** Linear  
**Units:** Unitless

Waste on floor effect on water pollution

**Data:** 5000,0.02; 10000,0.05; 20000,0.1; 33000,0.15; 50000,0.2  
**Source:** Waste on floor  
**Interpolation:** Linear  
**Units:** Unitless