Supplementary materials

Section A: The PORTTHERM-WPC sub-models

Model description

The PORTTHERM-WPC model consists of seven sub-models, namely i) the *Acacia saligna* clearance sub-model, ii) the WPC production sub-model, iii) the material and production cost sub-model, iv) the clearing cost sub-model, v) the carbon sequestration sub-model, vi) the water consumption sub-model and vii) the net present value sub-model. The parameters used in this study, as well as the respective equations used to derive the endogenous variables, are shown in Section C in the supplementary materials segment, with its supporting causal loop diagram (i.e. qualitative system dynamics model) presented in Section D (in the supplementary materials segment). Section E offers the model boundary chart, which illustrates the endogenous, exogenous and excluded variables used in the model. The exogenous variables are those variables that are derived from factors external to the system modelled, while the endogenous variables are those that are derived from within the model through equations. Excluded variables refer to those variables that are included within the qualitative system dynamics model (i.e. the causal loop diagram), but are excluded from the model simulations, either because of a lack of data or because they are beyond the scope of the study.

The *Acacia saligna* clearance sub-model

This sub-model establishes the area invaded by *Acacia saligna* that is cleared in the three study sites. It consists of three stock variables representing the three study areas under invasion by *Acacia saligna*. Stock variables refer to the accumulations within the system that are increased by inflows and drained by outflows. The areas invaded by *Acacia saligna* are increased by its re-growth, which is influenced by the growth rate of *Acacia saligna* and the area invaded. The areas invaded by *Acacia saligna* are drained by the clearing operations, which are influenced by the effect of person days on hectares cleared and the proportion invaded by *Acacia saligna* relative to other IAPs invading the sites under investigation. Figure A1 below illustrates this sub-model in greater detail.

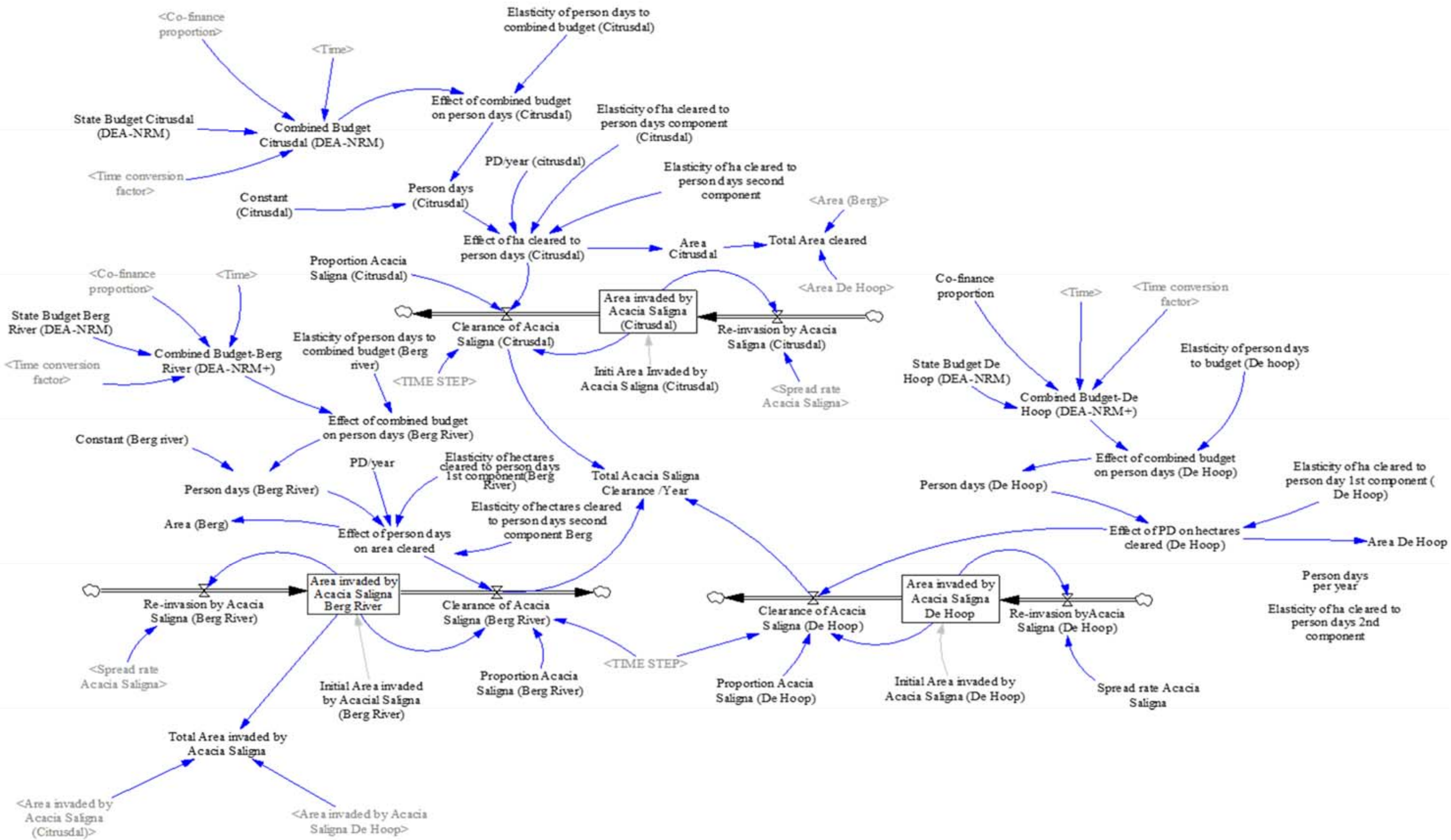


Figure A1: The *Acacia saligna* clearance sub-model
Source: Own analysis

The WPC production sub-model

This sub-model models the amount of WPCs produced from *Acacia saligna* wood flour and recycled thermoplastic waste in a 50:50 ratio. In this sub-model, low-density polyethylene (LDPE) recycled thermoplastics are considered for the production of WPCs. The *Acacia saligna* wood flour is a function of the dry useable biomass. The recycled thermoplastic granules are apportioned in the same quantity as the total amount of *Acacia saligna* wood flour generated per annum. The raw WPC material is then moulded into solid wall cladding and decking planks. The production of WPC solid decking planks (150 x 18 x 5 800 mm) and WPC wall cladding planks (145 x 12 x 5 800 mm) is assumed to be at a pro-rata basis, with 50% of the raw WPC being moulded into each of the two value-added products considered here. The weight of the WPC products is then derived as the density multiplied by the volume of the products. Thereafter, the gross value of the manufactured WPC products is derived as a function of the price per unit (ZAR/plank) and the number of WPC products (planks) produced per annum. Furthermore, the total gross value of all combined products (WPC wall cladding planks and decking planks) is derived by adding their respective gross values. Lastly, the net value of all WPC products combined is calculated by subtracting the total material and production cost for WPC products produced and the total clearing and wood-processing costs from the gross production value. The WPC production sub-model is shown in detail in Figure A2.

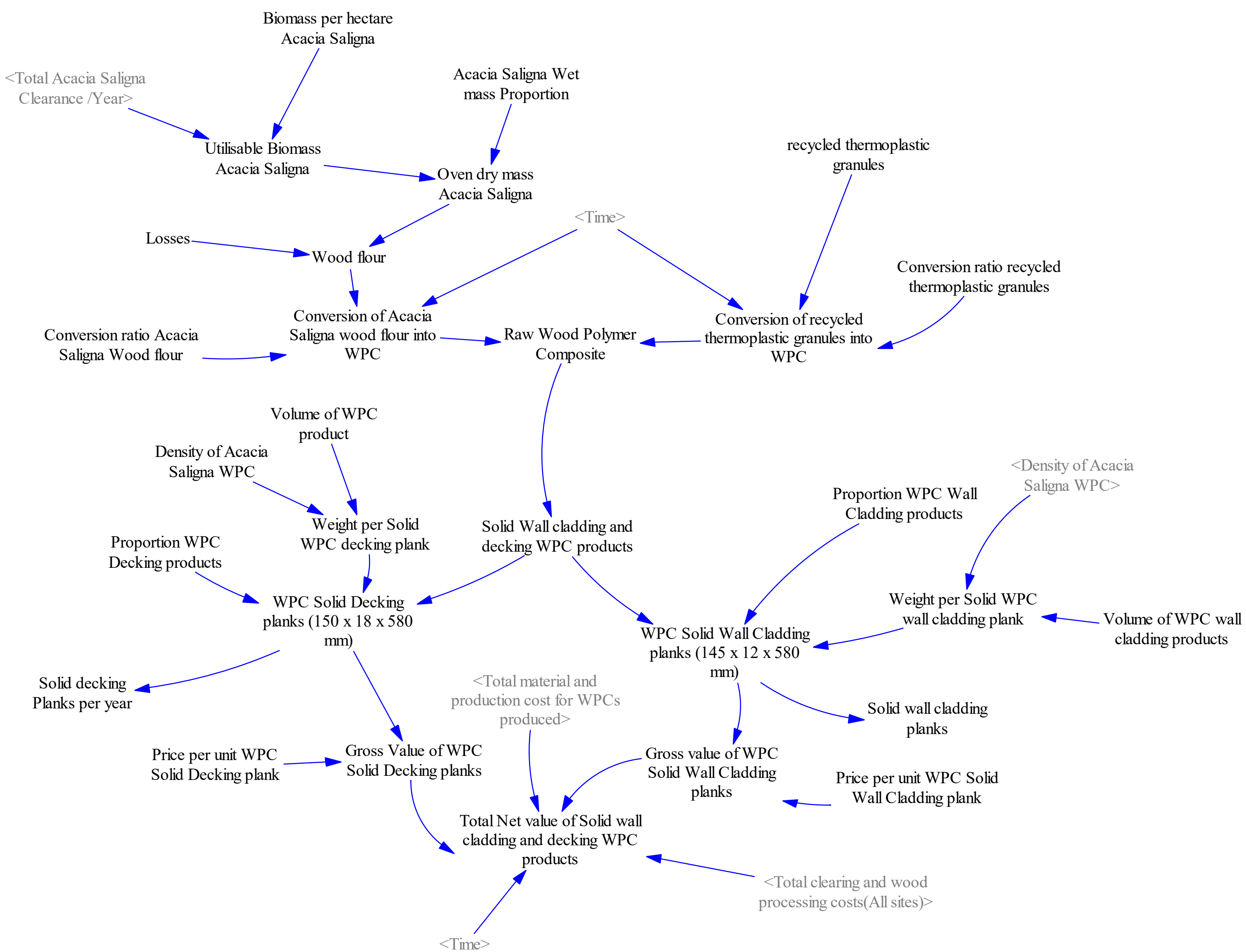


Figure A2: The WPC production sub-model

Source: Own analysis

The materials and production cost sub-model

The materials and production cost sub-model establishes the production and manufacturing costs incurred when undertaking the production of WPCs (see Figure A3). According to Rowell (1998, modified), the materials costs of WPCs are derived as follows:

$$ZAR/ton = \frac{[P(X)+F(Y)+C]}{E} \quad (1)$$

where
ZAR/ton is the production costs in ZAR per ton
P is the percentage of plastic in the composite
X is the estimated cost of the plastic in ZAR per ton
F is the percentage of *Acacia saligna* wood flour in the WPC
Y is the estimated cost of *Acacia saligna* wood flour per ton
C is the cost of compounding in ZAR per ton
E is the efficiency of operation, assumed here to be equal to 1

The materials cost, however, is only a proportion of the total manufacturing costs (viz. 77%). In addition, 15% of the total cost represents machine costs, while 5%, 7% and 3% represent the proportion spent on tools, labour, and packaging and transport respectively (Ghasem 2013). Lastly, a 5% conservative provision (as a percentage of the total material and production costs) was allowed to cater for the logistical costs associated with providing other non-IAP raw materials used in the WPC production process.

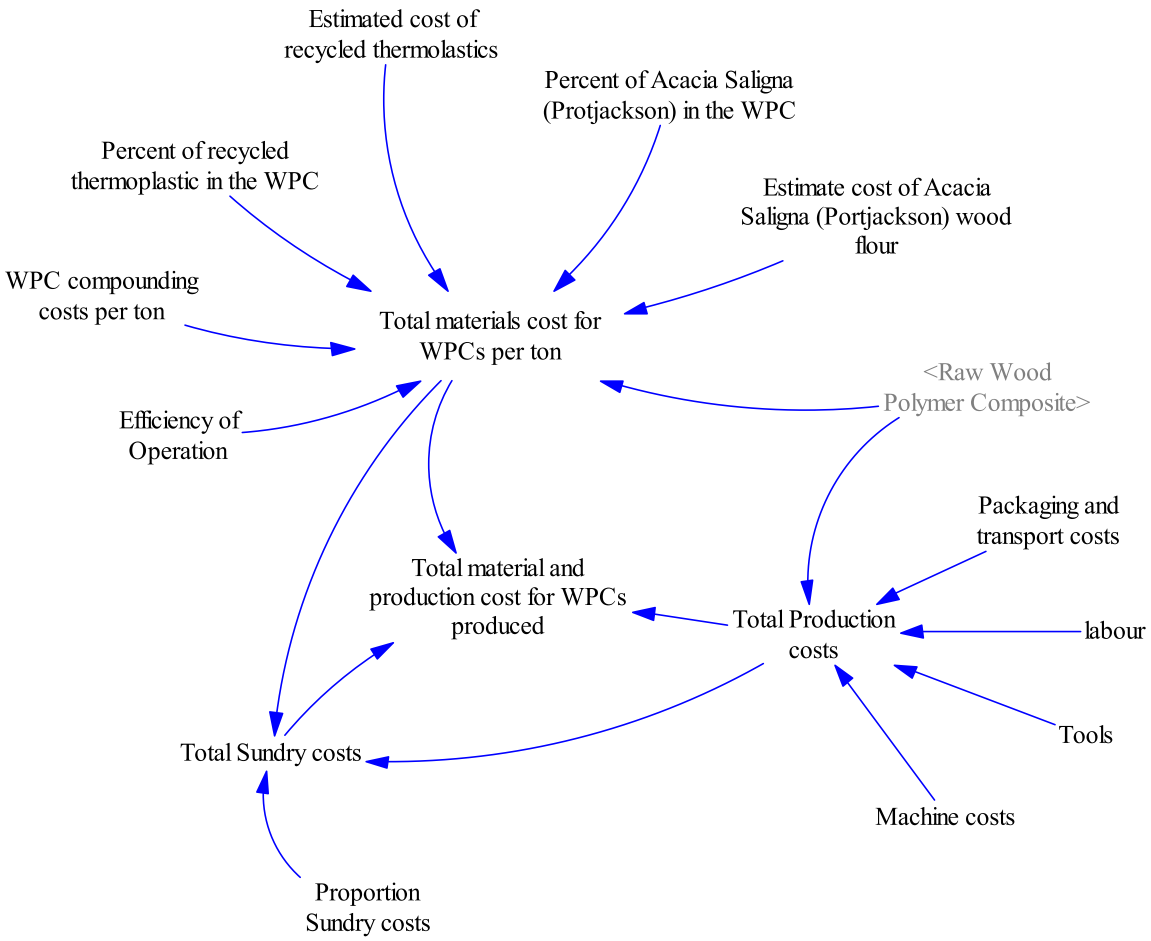


Figure A3: Materials and production cost sub-model
Source: Own analysis

The establishment cost sub-model

The establishment cost sub-model establishes the once-off cost to setting up the WPC production plant. The complete plant consists of five sub-components (consisting of five units for each component), namely the WPC profile extrusion plant machine, the high-speed mixer machine, the vertical type cooling blender machine, the pelletiser extrusion line machine and the wood powder machine. The total WPC once-off factory establishment cost is derived through the product of the number of units for each component and the respective price (cost) per component of the aforementioned five sub-components. The establishment cost sub-model is illustrated in Figure A4.

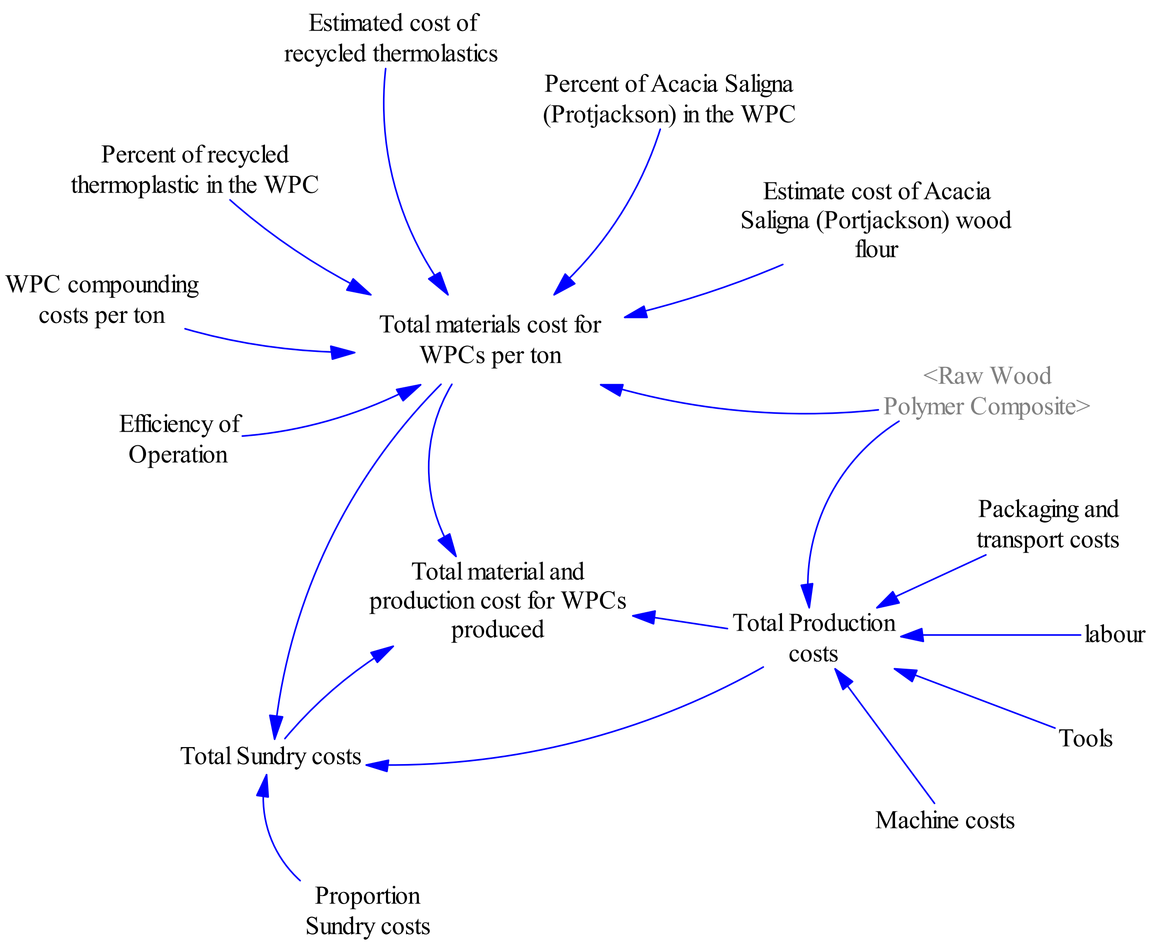


Figure A4: The cost sub-model of the establishment of the WPC production plant
Source: Own analysis

The clearing and wood process cost sub-model

The clearing cost sub-model models the total clearing and wood-processing costs incurred to clear *Acacia saligna* from the study sites. The unit clearing cost is a function of the combined clearing budget for the sites and the annual clearance (ha) of *Acacia saligna*. The combined budget refers to the total amount of money invested by the DEA: NRM to clear *Acacia saligna* along with a co-finance option from the private sector that augments the funding provided by the government. Chipping and transport costs per hectare cleared are then added to give the total clearing and wood-processing cost. The clearing cost sub-model is shown in Figure A5.

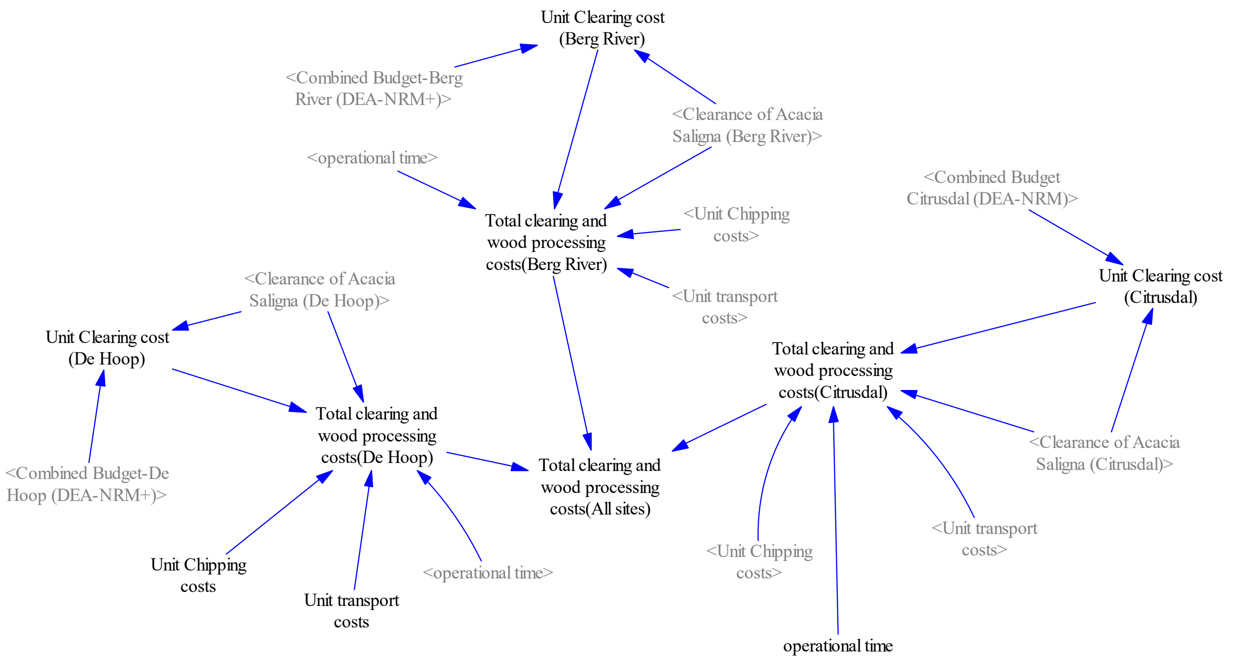


Figure A5: The clearing and wood processing cost sub-model
Source: Own analysis

The carbon sequestration sub-model

The carbon sequestration sub-model establishes the value of net carbon stock sequestered, stored and removed that is lost as a result of clearing *Acacia saligna*, and the carbon sequestered and stored as a result of re-invasion by *Acacia saligna*. *Acacia saligna* sequesters and stores carbon from the atmosphere as a result of photosynthesis. Thus, by clearing *Acacia saligna* there is an opportunity cost involved due to the loss of carbon sequestration potential which is, to a certain extent, offset as a result of re-invasion. The carbon sequestration potential is derived from the production of *Acacia saligna* biomass, the net dry mass conversion ratio of *Acacia saligna*, the clearance of *Acacia saligna* (or re-invasion by *Acacia saligna* in the case of carbon sequestered as a result of re-invasion by new *Acacia saligna* plants) and the CO_2:C ratio. The value of the net carbon sequestered and stored that is removed is then calculated by multiplying the net carbon removed (i.e. net carbon sequestered and removed due to clearance, less the carbon addition emanating from re-invasion by *Acacia saligna*) and the unit price of carbon. The carbon sequestration sub-model is shown in Figure A6.

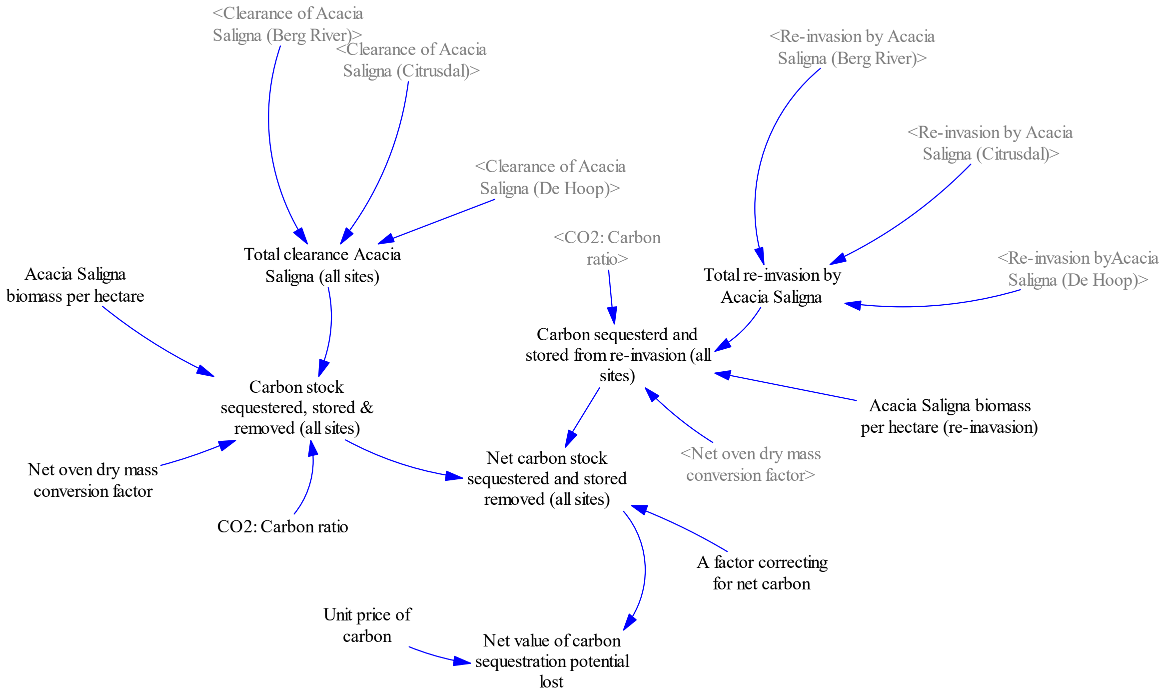


Figure A6: The carbon sequestration sub-model
Source: Own analysis

The water consumption sub-model

This sub-model estimates the water reduction caused by the invasion by *Acacia saligna* within the study sites. Water that was previously consumed by these IAPs is saved as a result of clearing, and augments the water supply from the Berg River and the Olifants River in the Western Cape. This water becomes available for other uses, such as agricultural irrigation and the supply of potable water to residential and industrial areas supplied by these water bodies. The water savings from De Hoop are not considered in this study, since all the water saved due to the clearing of IAPs flows to the ocean (Mudavanhu *et al*. 2016). The water that is used by *Acacia saligna* is derived from the product of water reduction per hectare by *Acacia saligna* and the clearance of *Acacia saligna*. The monetary value of water that is saved as a result of clearing is then calculated by multiplying the unit value of water and the water used by *Acacia saligna* that has become freed after the clearing operations. This sub-model is illustrated in Figure A7.

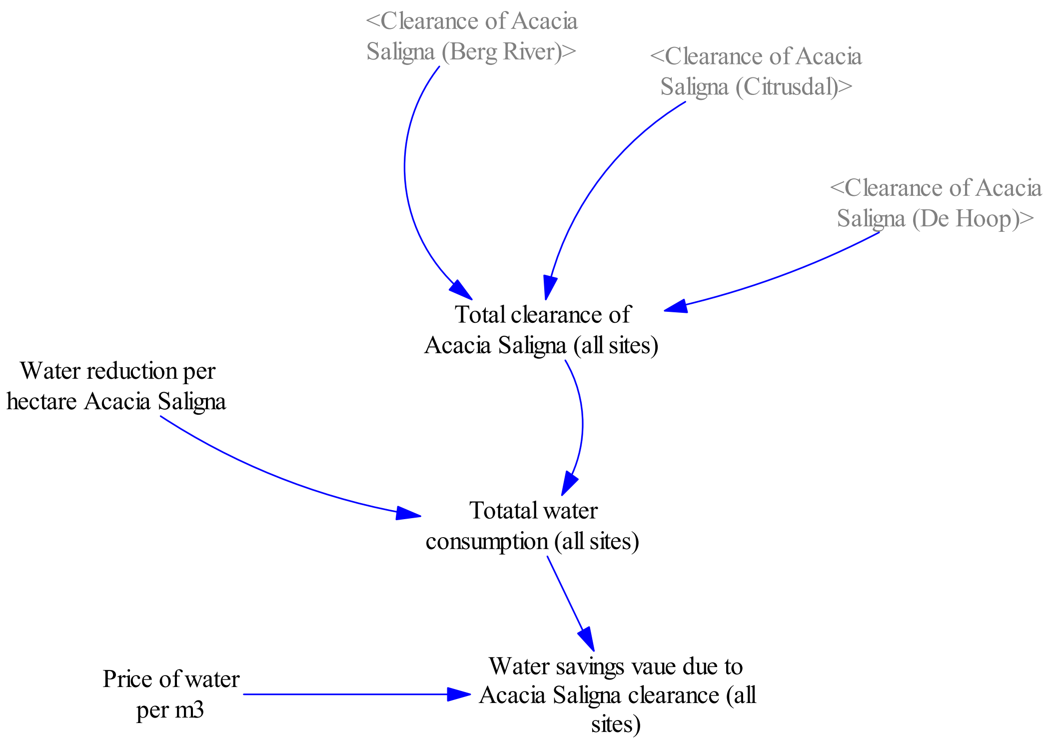


Figure A7: Water consumption sub-model
Source: Own analysis

The NPV sub-model

This sub-model estimates both the costs and the benefits of using wood flour derived from *Acacia saligna* and recycled thermoplastic to make WPCs by estimating the net present value of the operations. This analysis is important in order to determine its economic feasibility. The net benefits from using *Acacia saligna* wood flour and thermoplastic waste to make WPCs is derived through the following equation(s):

Net benefits = Total benefits – Total costs (2)

where:

Total benefits = Value of water savings due to *Acacia saligna* clearance + Total net value of solid wall cladding and decking WPC products (3)

Total costs = Total clearing and wood-processing costs + Carbon sequestration potential lost + Total material and production costs + Total WPC factory establishment costs (4)

The net present value is then derived by dividing the net income from the sale of WPCs and the value of water savings by the discount factor. The net present value is then accumulated for the entire simulation period to give the cumulative NPV (see Figure A8).

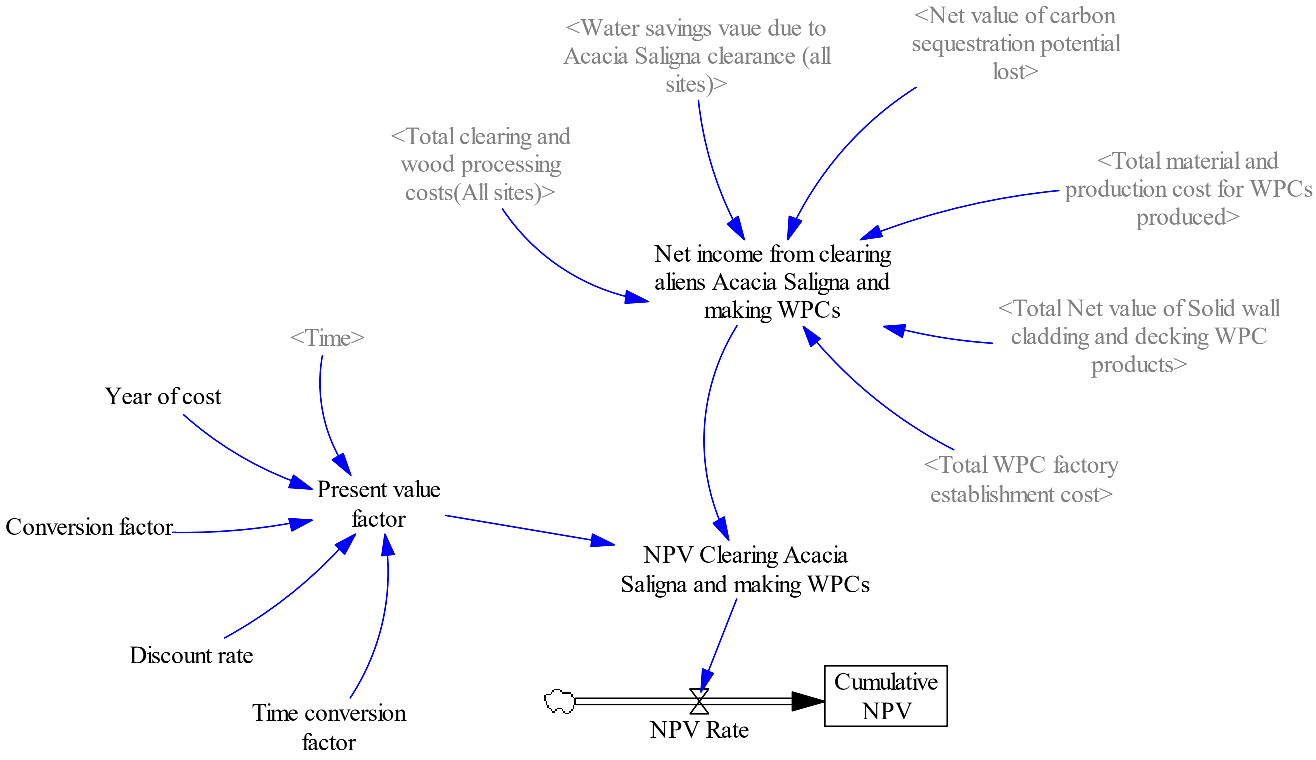


Figure A8: The net present value (NPV) sub-model
Source: Own analysis

Section B: Physical and mechanical properties of Port Jackson (*Acacia saligna*) WPC

Composite	Physical		Mechanical				
	MC (%)	Density (g/cm^3)	Tensile strength (MPa)	Tensile modulus (MPa)	Elongation (%)	Impact	Hardness
LDPE + 50% wood flour	-	-	11.78 ± 1.04	1 309.06 ± 165.73	2.57 ± 0.12	6.9 ± 0.82	61.7 ± 2.02
LDPE + 50% wood flour + 10% PE-g-MA	4.24 ± 0.13	0.99 ± 0.01	16.25 ± 2.34	1 354.6 ± 230.15	2.8 ± 0.55	8.4 ± 0.82	60.8 ± 4.83

Source: Adapted with permission from Effah *et al*. (2017)

Section C: Model parameters and equations used in the PORTTHERM-WPC model

Parameters of *Acacia saligna* clearance sub-model				
Variable	**Value/formula**	**Units**	**Data source**	**Comments**
"Co-finance proportion"	1	Dmnl	Policy variable	
"State budget Citrusdal (DEA-NRM)"	Lookup	R/year	DEA-NRM (2016)	
Time conversion factor	1	year	Policy variable	
Time	Internally defined in model	year		
"Elasticity of person days to combined budget (Citrusdal)"	0.0056	PD/R	Own calculation	
"Constant"	255.86	PD/year	Own calculation	
"PD/year (Citrusdal)"	1	PD/year	Policy variable	
"Elasticity of ha cleared to person days component (Citrusdal)"	-3e-007	ha/PD	Own calculation	
Elasticity of ha cleared to person days second component	0.0233	ha/PD	Own calculation	
"Proportion *Acacia saligna* (Citrusdal)"	0.38	Dmnl	Own calculation	
TIME STEP	1	Year	Policy variable	
"Initial area invaded by *Acacia saligna* (Citrusdal)"	530.714	Ha	DEA-NRM (2016)	
Spread rate *Acacia saligna*	0.15	Dmnl/year	Van Wilgen & Le Maitre (2013)	Conservative estimate of annual spread rate
"State budget Berg River (DEA-NRM)"	Lookup	R/year	DEA-NRM (2016)	
"Elasticity of person days to combined budget (Berg River)"	0.0035	PD/R	Own calculation	
"Constant (Berg River)"	5 114.9	PD/year	Own calculation	
"Elasticity of hectares cleared to person days 1st component (Berg River)"	79.409	ha/PD	Own calculation	
"Elasticity of hectares cleared to person days 2nd component (Berg River)"	0.0001	ha/PD	Own calculation	
"Proportion *Acacia saligna* (Berg River)"	0.0983	Dmnl	Own calculation	
"Initial area invaded by *Acacia saligna* (Berg River)"	849.69	ha	DEA-NRM (2016)	
"State budget De Hoop (DEA-NRM)"	Lookup	R/year	DEA-NRM (2016)	
"Elasticity of person days to budget (De Hoop)"	0.0049	PD/R	Own calculation	
"Elasticity of ha cleared to person day 1st component (De Hoop)"	1 894.9	ha/PD	Own calculation	
"Initial area invaded by *Acacia saligna* (De Hoop)"	233.75	ha	DEA-NRM (2016)	

"Proportion *Acacia saligna* (De Hoop)"	0.0983	Dmnl	Own calculation	
Equations for *Acacia saligna* clearance sub-model				
Variable	**Value/formula**	**Units**	**Data source**	**Comments**
"Combined budget Citrusdal (DEA-NRM)"	"Co-finance proportion"* "State budget Citrusdal (DEA-NRM)"(Time/time conversion factor)	R/year	Own calculation	
"Effect of combined budget on person days (Citrusdal)"	"Combined budget Citrusdal (DEA-NRM)" *"Elasticity of person days to combined budget (Citrusdal)"	PD/year	Own calculation	
"Person days (Citrusdal)"	"Effect of combined budget on person days (Citrusdal)"+"Constant (Citrusdal)"	PD/year	Own calculation	
"Effect of ha cleared to person days (Citrusdal)"	(("Elasticity of ha cleared to person days component (Citrusdal)"*("Person days (Citrusdal)"*"Person days (Citrusdal)"))/"PD/year (Citrusdal)")+(Elasticity of ha cleared to person days second component* "Person days (Citrusdal)")	ha/year	Own calculation	
Area Citrusdal	"Effect of ha cleared to person days (Citrusdal)"+1.9165	ha/year	Own calculation	
Total area cleared	Area Citrusdal +"Area (Berg)"+Area De Hoop	ha/year	Own calculation	
"Clearance of *Acacia saligna* (Citrusdal)"	MIN(("Effect of ha cleared to person days (Citrusdal)"+1.9165)*"Pro portion *Acacia saligna* (Citrusdal)", "Area invaded by *Acacia saligna* (Citrusdal)"/TIME STEP)	ha/year	Own calculation	

"Re-invasion by *Acacia saligna* (Citrusdal)"	"Area invaded by *Acacia saligna* (Citrusdal)"* Spread rate *Acacia saligna*	ha/year	Own calculation	
"Area invaded by *Acacia saligna* (Citrusdal)"	INTEG("Re-invasion by *Acacia saligna* (Citrusdal)" -"Clearance of *Acacia saligna* (Citrusdal)")			
"Combined budget Berg River (DEA-NRM+)"	"Co-finance proportion" *"State budget Berg River (DEA-NRM)"(Time/Time conversion factor)	R/year	Own calculation	
"Effect of combined budget on person days (Berg River)"	"Combined budget-Berg River (DEA-NRM+)"* "Elasticity of person days to combined budget (Berg River)"	PD/year	Own calculation	
"Person days (Berg River)"	"Effect of combined budget on person days (Berg River)"+"Constant (Berg River)"	PD/year	Own calculation	
Effect of person days on area cleared	"Elasticity of hectares cleared to person days (Berg River)"*"Person days (Berg River)"	ha/year	Own calculation	
"Re-invasion by *Acacia saligna* (Berg River)"	Area invaded by *Acacia saligna* Berg River*Spread rate *Acacia saligna*	ha/year	Own calculation	
"Clearance of *Acacia saligna* (Berg River)"	MIN((Effect of person days on area cleared-149293)*"Proportion *Acacia saligna* (Berg River)", Area invaded by *Acacia saligna* Berg River/TIME STEP)	ha/year	Own calculation	
Area invaded by *Acacia saligna* Berg River	INTEG("Re-invasion by *Acacia saligna* (Berg River)"-"Clearance of *Acacia saligna* (Berg River)")	ha	Own calculation	

Total area invaded by *Acacia saligna*	"Area invaded by *Acacia saligna* (Citrusdal)"+Area invaded by *Acacia saligna* Berg River + Area invaded by *Acacia saligna* De Hoop	ha	Own calculation	
"Combined budget De Hoop (DEA-NRM+)"	"Co-finance proportion"* "State budget De Hoop (DEA-NRM)"(Time/Time conversion factor)	R/year	Own calculation	
"Effect of combined budget on person days (De Hoop)"	"Combined budget-De Hoop (DEA-NRM+)"* "Elasticity of person days to budget (De Hoop)"	PD/year	Own calculation	
"Person days (De Hoop)"	"Effect of combined budget on person days (De Hoop)"-315.26	PD/year	Own calculation	
"Effect of PD on hectares cleared (De Hoop)"	(("Elasticity of ha cleared to person day 1st component (De Hoop)"* ("Person days (De Hoop)"*"Person days (De Hoop)"))/"PD/year")+(Elasticity of ha cleared to person days 2nd component*"Person days (De Hoop)")	ha/year	Own calculation	
"Re-invasion by *Acacia saligna* (De Hoop)"	Area invaded by *Acacia saligna* De Hoop*Spread rate *Acacia saligna*	ha/year	Own calculation	
"Clearance of *Acacia saligna* (De Hoop)"	MIN("Effect of PD on hectares cleared (De Hoop)"*"Proportion *Acacia saligna* (De Hoop)", Area invaded by *Acacia saligna* De Hoop/ TIME STEP)	ha/year	Own calculation	
Area invaded by *Acacia saligna* De Hoop	INTEG("Re-invasion by *Acacia saligna* (De Hoop)" -"Clearance of *Acacia saligna* (De Hoop)")	ha	Own calculation	

Parameters of WPC production sub-model				
Variable	**Value/formula**	**Units**	**Data source**	**Comments**
Biomass per hectare *Acacia saligna*	23.2	ton/ha	Mugido *et al*. (2014)	Conservative estimates
Acacia saligna wet mass proportion	0.55	Dmnl	Thomas & Martin (2012)	55% moisture is removed from cleared biomass to be left with the 45% oven dry mass
Conversion ratio *Acacia saligna* wood flour	1	Dmnl	Effah *et al*. (2017)	Assuming a 50:50 ratio of wood flour to thermoplastics
Losses	0.1	Dmnl	Consultation with experts	Conservative estimate based on consultation with experts
Recycled thermoplastics	583.212	ton/year	Own calculation	
Conversion ratio recycled thermoplastic granules	1	Dmnl	Effah *et al*. (2017)	Assuming a 50:5% ratio of wood flour and thermoplastics
Volume of WPC product (solid decking plank 150*18*580 mm)	1 566	cm^3	Own calculation	
Density of *Acacia saligna* WPC	9.9e-007	ton/cm^3		
Proportion sundry costs	0.05	Dmnl	Policy variable	Assumption made for modelling purposes
Proportion WPC decking products	0.5	Dmnl	Policy variable	Assumption made for modelling purposes
Proportion WPC wall cladding products	0.5	Dmnl	Policy variable	Assumption made for modelling purposes
Volume of WPC wall cladding products (145*12*580 mm)	1 009.2	cm^3	Own calculation	
Price per unit WPC solid wall cladding plank	505	R/plank	www.nudek.co.za	
Price per unit WPC solid decking plank	675	R/plank	www.nudek.co.za	
Equations for WPC production sub-model				
Variable	**Value/formula**	**Units**	**Data source**	**Comments**
Utilisable biomass *Acacia saligna*	Biomass per hectare *Acacia saligna**"Total *Acacia saligna* clearance/ Year"	ton/year	Own calculation	
Oven dry mass *Acacia saligna*	Utilisable biomass *Acacia saligna**(1-*Acacia saligna* wet mass proportion)	ton/year	Own calculation	
Utilisable thermoplastic waste	Recoverable percentage*"Total thermoplastic waste generated/year in the City of Cape Town"	ton/year	Own calculation	

Wood flour	Oven dry mass *Acacia saligna*-(Oven dry mass *Acacia saligna**Losses)	ton/year	Own calculation	
Recycled thermoplastic granules	Utilisable thermoplastic waste-(Utilisable thermoplastic waste* Losses)	ton/year	Own calculation	
Conversion of *Acacia saligna* wood flour into WPC	Conversion ratio *Acacia saligna* wood flour*Wood flour	ton/year	Own calculation	
Conversion of recycled thermoplastic granules into WPC	Conversion ratio recycled thermoplastic granules* recycled thermoplastic granules	ton/year	Own calculation	
Raw wood polymer composite	Conversion of *Acacia saligna* wood flour into WPC + Conversion of recycled thermoplastic granules into WPC	ton/year	Own calculation	
Weight per solid WPC decking plank	Density of *Acacia saligna* WPC*Volume of WPC product	ton/plank	Own calculation	
Solid wall cladding and decking WPC products	(Raw wood polymer composite)/(WPC extruder units*Output per hour* Total production hours per annum)*A factor correcting for WPC	ton/year	Own calculation	
"WPC solid wall cladding planks (145 x 12 x 580 mm)"	(Proportion WPC wall cladding products*Solid wall cladding and decking WPC products)/Weight per solid WPC wall cladding plank	plank/year	Own calculation	
"WPC solid decking planks (150 x 18 x 580 mm)"	(Proportion WPC decking products*Solid wall cladding and decking WPC products)/Weight per solid WPC decking plank	plank/year	Own calculation	

Gross value of WPC solid decking planks	Price per unit WPC solid decking plank*"WPC solid decking planks (150 x 18 x 580 mm)"	R/year	Own calculation	
Gross value of WPC solid wall cladding planks	Price per unit WPC solid wall cladding plank*"WPC solid wall cladding planks (145 x 12 x 580 mm)"	R/year	Own calculation	
Total gross value of solid wall cladding and decking WPC products	Gross value of WPC solid decking planks + Gross value of WPC solid wall cladding planks	R/year	Own calculation	
Parameters of the material and production cost sub-model				
Variable	**Value/formula**	**Units**	**Data source**	**Comments**
Estimated cost of recycled thermoplastics	3 120	R/ton	Green Cape (2016)	Conservative estimate
"Estimate cost of *Acacia saligna* (Port Jackson) wood flour"	0	R/ton		The cost is zero since there will be no cost of buying the wood biomass from *Acacia saligna*. They just clear and use the biomass
Efficiency of operation	1	Dmnl	Rowell (1998)	
"Percent of *Acacia saligna* (Port Jackson) in the WPC"	1	Dmnl	Effah *et al*. (2017)	Assuming a 50:50 ratio of wood flour and thermoplastics
Percentage of recycled thermoplastic in the WPC	1	Dmnl	Effah *et al*. (2017)	Assuming a 50:50 ratio of wood flour and thermoplastics
WPC compounding costs per ton	837.408	R/ton	Ghasem (2013)	Conservative estimate
Equations for material and production cost of WPC sub-model				
Variable	**Value/formula**	**Units**	**Data source**	**Comments**
Total materials and production cost for WPCs per ton	("Percent of *Acacia saligna* (Port Jackson) in the WPC"*"Estimate cost of *Acacia saligna* (Port Jackson) wood flour" +Percent of recycled thermoplastic in the WPC*Estimated cost of recycled thermoplastics +WPC compounding costs	R/ton	Rowell (1998)	Conservative estimate

	per ton)/Efficiency of operation			
Total material and production cost for WPCs produced	Raw wood polymer composite*Total materials and production cost for WPCs per ton	R/year	Own calculation	
Total sundry costs	Proportion sundry costs* (Total materials cost for WPCs per ton +Total production costs)	R/year	Own calculation	
Parameters of WPC production plant establishment cost sub-model				
Variable	**Value/formula**	**Units**	**Data source**	**Comments**
Cost of WPC profile extrusion plant machine	1 820 000	R	http://www.made-in-china.com/products-search/hot-china-products/Wpc_Board_Plant.html	
Number of WPC profile extrusion machines	5	Dmnl	Model assumption	Two machines with an output of 650 kg per hour are enough; however, we assumed five were needed to cater for possible breakdowns and other unforeseen circumstances
Cost of high-speed mixer machines	2 184 000	R	http://www.made-in-china.com/price/high-speed-mixer-price.html	
Number of high-speed mixer machines	5	Dmnl	Model assumption	Two machines with an output of 650 kg per hour are enough; however, we assumed five were needed to cater for possible breakdowns and other unforeseen circumstances
Cost of vertical-type cooling blender machine	1 400 000	R	http://shica-machinery.en.made-in-china.com/product/lXynrTUWEdcF/China-Stainless-Steel-Vertical-Paddle-PVC-Mixer-Machine.html	
Number of vertical-type cooling blender machines	5	Dmnl	Model assumption	Two machines with an output of 650 kg per hour are enough; however, we assumed five were needed to cater for possible breakdowns and other unforeseen circumstances
Cost of pelletiser extrusion line	490 000	R	http://faygounion.en.made-in-china.com/product/kvMQEOiwyNVK/China-PVC-Plastic-Compound-Granules-for-Pelletizer-Extrusion-Line-Price.htm	

Number of pelletiser extrusion line machines	5	Dmnl	Model assumption	Two machines with an output of 650 kg per hour are enough; however, we assumed five were needed to cater for possible breakdowns and other unforeseen circumstances
Cost of wood powder machine	350 000	R	http://ww.alibaba.com/showroom/wood-powder-making-machine-for-sale.html	
Number of wood powder machines	5	Dmnl	Model assumption	Two machines with an output of 650 kg per hour are enough; however, we assumed five were needed to cater for possible breakdowns and other unforeseen circumstances
Total WPC production plant establishment cost	IF THEN ELSE(Time= 2017, ((Cost of high-speed mixer machine*Number of high-speed mixer machines)+(Cost of pelletiser extrusion line* Number of pelletiser extrusion line)+(Cost of vertical type cooling blender machine*Number of vertical blender machines)+(Cost of wood powder machine*Number of wood powder machines) +(Number of WPC profile extrusion plant*Cost of WPC profile extrusion plant))*A factor correcting for establishment cost, 0)	R/year	Own calculation	
Equations for clearing and wood-processing cost sub-model				
Variable	**Value/formula**	**Units**	**Data source**	**Comments**
"Unit clearing cost (Berg River)"	"Combined budget-Berg River (DEA-NRM+)"/ "Clearance of *Acacia saligna* (Berg River)"	R/ha	Own calculation	
"Unit clearing cost (De Hoop)"	"Combined budget-De Hoop (DEA-NRM+)"/	R/ha	Own calculation	

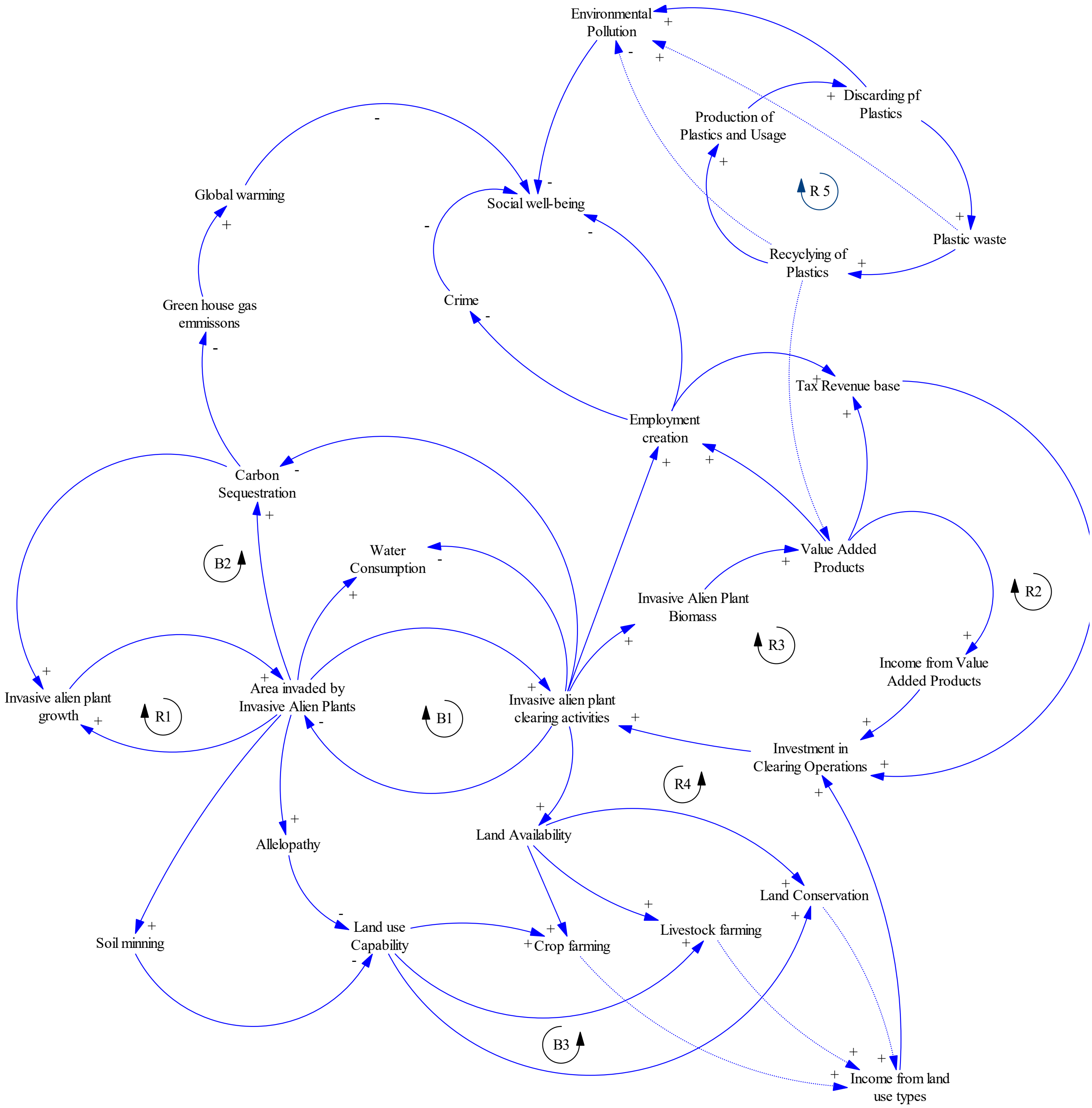
	"Clearance of *Acacia saligna* (De Hoop)"			
"Unit clearing cost (Citrusdal)"	"Combined budget Citrusdal (DEA-NRM)"/ "Clearance of *Acacia saligna* (Citrusdal)"	R/ha	Own calculation	
Unit chipping cost	6 428	R/ha	Mugido *et al*. (2014)	2013 values adjusted to current prices using the 2017 CPI index adapted by StatsSA (2017)
Unit transport cost	3 908	R/ha	Mugido *et al*. (2014)	2013 values adjusted to current prices using the 2017 CPI index adapted by StatsSA (2017)
"Total clearing and wood processing cost (De Hoop)"	("Clearance of *Acacia saligna* (De Hoop)"*"Unit clearing cost (De Hoop)")+(Clearance of *Acacia saligna* (De Hoop)*unit chipping cost*operational time)+(Clearance of *Acacia saligna* (De Hoop)*unit transport cost*operational time)	R/year	Own calculation	
"Total clearing cost (Berg River)"	"Clearance of *Acacia saligna* (Berg River)"* "Unit clearing cost (Berg River)"+(Clearance of *Acacia saligna* Berg River*unit chipping cost* operational time)+ (Clearance of *Acacia saligna* (Berg River)*unit transport cost*operational time)	R/year	Own calculation	
"Total clearing cost (Citrusdal)"	"Clearance of *Acacia saligna* (Citrusdal)"*"Unit clearing cost (Citrusdal)"+ (Clearance of *Acacia saligna* (Citrusdal*unit chipping cost*operational time)+(Clearance of *Acacia saligna* (Citrusdal) *unit transport cost* operational time)	R/year	Own calculation	

"Total clearing costs (all sites)"	"Total clearing and wood-processing costs(Berg River)"+"Total clearing and wood-processing costs(Citrusdal)" +"Total clearing and wood-processing costs(De Hoop)"	R/year	Own calculation	
Parameters of carbon sequestration sub-model				
Variable	**Value/formula**	**Units**	**Data source**	**Comments**
Acacia saligna biomass per hectare	23.2	ton/ha	Mugido *et al*. (2014)	Conservative estimates
"*Acacia saligna* biomass per hectare (re-invasion)"	2.32	ton/ha	Conservative estimate based on consultation with experts	It takes 10 years for *Acacia saligna* to reach full biomass and hence we divide the full biomass by 10 years to get biomass of re-invasion per annum
A factor correcting for net carbon	0.75	Dmnl	Policy variable	
Net oven dry mass conversion factor	0.45	Dmnl	Thomas & Martin (2012)	55% moisture is removed from cleared biomass to be left with the 45% oven dry mass
"CO2: Carbon ratio"	3.6667	Dmnl	Thomas & Martin (2012)	3.6667 is the ratio of CO_2 over carbon
Unit price of carbon	120	R/ton	National Treasury (2013)	
Equations for carbon sequestration sub-model				
Variable	**Value/formula**	**Units**	**Data source**	**Comments**
"Total clearance *Acacia saligna* (all sites)"	"Clearance of *Acacia saligna* (Berg River)"+ "Clearance of *Acacia saligna* (Citrusdal)"+ "Clearance of *Acacia saligna* (De Hoop)"	ha/year	Own calculation	
"Carbon stock sequestered and stored (all sites)"	*Acacia saligna* biomass per hectare*"Total clearance *Acacia saligna* (all sites)"*Net oven dry mass conversion factor* "CO2: Carbon ratio"	ton/year	Own calculation	
"Net carbon stock sequestered and stored removed (all sites)"	(("Carbon stock sequestered, stored & removed (all sites)")- "Carbon sequestered and	ton/year	Own calculation	

	stored from re-invasion (all sites)")*A factor correcting for net carbon			
Net value of carbon sequestration potential lost	"Net carbon stock sequestered and stored & removed (all sites)"*Unit price of carbon	R/year	Own calculation	
"Carbon sequestered and stored from re-invasion (all sites)"	"*Acacia saligna* biomass per hectare (re-invasion)"* "Total re-invasion by *Acacia saligna*"*"CO2: Carbon ratio"*Net oven dry mass conversion factor	ton/year	Own calculation	
"Total re-invasion by *Acacia saligna*"	"Re-invasion by *Acacia saligna* (Berg River)"+ "Re-invasion by *Acacia saligna* (Citrusdal)"+"Re-invasion by *Acacia saligna* (De Hoop)"	ton/year	Own calculation	
Parameters of water consumption sub-model				
Variable	**Value/formula**	**Units**	**Data source**	**Comments**
Water reduction per hectare *Acacia saligna*	634.81	m^3/ha	Le Maitre *et al*. (2015)	An estimate for the whole country
Unit value of water	2	R/m^3	Consultation with anonymous farmers and experts	Conservative estimate for the Orange River irrigation water
Equations for water consumption sub-model				
Variable	**Value/formula**	**Units**	**Data source**	**Comments**
"Total clearance of *Acacia saligna* (all sites)"	"Clearance of *Acacia saligna* (Berg River)"+ "Clearance of *Acacia saligna* (Citrusdal)"+ "Clearance of *Acacia saligna* (De Hoop)"	ha/year	Own calculation	
"Total water consumption (all sites)"	"Total clearance of *Acacia saligna* (all sites)"*Water reduction per hectare *Acacia saligna*	m^3/year	Own calculation	

"Water savings value due to *Acacia saligna* clearance (all sites)"	Price of water per m^3* "Total water consumption (all sites)"	R/year	Own calculation	
Parameters of NPV sub-model				
Variable	**Value/formula**	**Units**	**Data source**	**Comments**
Year of cost	[(2 008,1)-(2 057,50)] Lookup	Dmnl	Policy variable	
Conversion factor	1	Dmnl	Policy variable	
Discount rate	0.06	Dmnl	Policy variable	Based on National Treasury rates
Time conversion factor	1	year	Policy variable	
Equations for NPV sub-model				
Variable	**Value/formula**	**Units**	**Data source**	**Comments**
Present value factor	((Conversion factor + Discount rate)^Year of cost((Time/Time conversion factor)))	Dmnl	Own calculation	
Net income from clearing alien *Acacia saligna* and making WPCs	Net value of carbon sequestration potential lost +"Total clearing costs (All sites)"+ Total material and production cost for WPCs produced + Total net value of solid wall cladding and decking WPC products +"Water savings value due to *Acacia saligna* clearance (all sites)"	R/year	Own calculation	
NPV clearing *Acacia saligna* and making WPCs	Net income from clearing aliens *Acacia saligna* and making WPCs/ Present value factor	R/year	Own calculation	
NPV clearing *Acacia saligna* and making WPCs	NPV clearing *Acacia saligna* and making WPCs	R/year	Own calculation	
Cumulative NPV	INTEG(NPV rate)	R	Own calculation	

Section D: Causal loop diagram (i.e. qualitative system dynamics model)



Section E: PORTTHERM-WPC model boundary chart

Exogenous variables	Endogenous variables	Excluded variables
A factor correcting for net carbon	"Area (Berg)"	Employment creation
A factor correcting for WPC	Area Citrusdal	Production of thermoplastic and usage
Acacia saligna biomass per hectare	Area De Hoop	Other types of recycled thermoplastic waste plastics (apart from LDPE)
Acacia saligna wet mass proportion	"Area invaded by *Acacia saligna* (all sites)	Other value-added products apart from WPCs
Biomass per hectare *Acacia saligna*	"Carbon stock sequestered and stored (all sites)	Other municipal solid waste factors
"Co-finance proportion"	"Clearance of *Acacia saligna* (all sites)"	WPC factory establishment costs
"CO2: Carbon ratio"	"Combined budget Citrusdal (DEA-NRM)" (all sites)	Land use options
"Constant (all sites)"	Conversion of *Acacia saligna* wood flour into WPC	Other negative impacts from IAPs (e.g. soil mining, allelopathy, decline in biodiversity, etc.)
Conversion factor	Conversion ratio recycled thermoplastic granules	Greenhouse gas emissions
Conversion ratio *Acacia saligna* wood flour	Cumulative NPV	Tax revenue base
Density of *Acacia saligna* WPC	Effect of combined budget on person days	Social wellbeing factors
Discount rate	"Effect of ha cleared to person days (all sites)"	Environmental pollution
Efficiency of operation	"Effect of PD on hectares cleared (all sites)"	Other costs (e.g. transport of biomass from sites, chipping costs, electrical, water, packaging and other sundry expenses)
Elasticity of person days to combined budget (all sites)	Gross value of WPC solid decking planks	Physical tensile strength of WPCs
Elasticity of ha cleared to person day (all sites)	Gross value of WPC solid wall cladding planks	Physical tensile modulus of WPCs
Estimated cost of *Acacia saligna* (Port Jackson) wood flour	"Net carbon stock sequestered and stored removed (all sites)"	Mechanical elongation of WPCs
Estimated cost of recycled thermoplastics	Net income from clearing aliens *Acacia saligna* and making WPCs	Mechanical impact of WPC
Final time	Net value of carbon sequestration potential lost	Mechanical hardness of WPCs
Initial area invaded by *Acacia saligna* (all sites)	NPV rate	Monomers
INITIAL TIME	Oven dry mass *Acacia saligna*	
Losses	Person days (all sites)	
Net oven dry mass conversion factor	Present value factor	
Output per hour	Raw wood polymer composite	
"PD/year"	"Re-invasion by *Acacia saligna* (all sites)	
"Percent of *Acacia saligna* (Port Jackson) in the WPC"	Recoverable percentage	
Percent of recycled thermoplastic in the WPC	Solid decking planks per year	
Price of water per m^3	Solid wall cladding planks	
Price per unit WPC solid decking plank	Solid wall cladding and decking WPC products	
Price per unit WPC solid wall cladding plank	Recycled thermoplastic granules	
Proportion *Acacia saligna* (all sites)	Total *Acacia saligna* clearance/year	
Proportion WPC decking products	Total area cleared (all sites)	

Proportion WPC wall cladding products	Total area invaded by *Acacia saligna* (all sites)	
Recoverable percentage (thermoplastic waste)	Total clearing cost (all sites)	
Spread rate *Acacia saligna*	Total materials and production cost for WPCs per ton	
State budget Berg River (DEA-NRM) (all sites)	Total net value of solid wall cladding and decking WPC products	
Time conversion factor	Total thermoplastic waste generated/ year in the City of Cape Town	
Total production hours per annum	Total water consumption (all sites)	
Unit price of carbon	Unit clearing cost (all sites)	
Volume of WPC decking products	Utilisable biomass *Acacia saligna*	
Volume of WPC wall cladding products	Utilisable thermoplastic waste (LDPE thermoplastics)	
Water reduction per hectare *Acacia saligna*	Weight per solid WPC decking plank	
WPC compounding costs per ton	Weight per solid WPC wall cladding plank	
WPC extruder units	Wood flour	
Year of cost	WPC solid decking planks (150 x 18 x 580 mm)	
	"WPC solid wall cladding planks (145 x 12 x 580 mm)"	

Section F: Summary table of annual externality costs (carbon sequestered, stored and removed) and benefits (water savings) emanating from the clearance of *Acacia saligna*

	Carbon sequestered, stored and removed [units]*				Water savings [units]*			
Time [year]	Baseline scenario [tons & (ZAR)]	Scenario 2 [tons & (ZAR)]	Scenario 3 [tons & (ZAR)]	Scenario 4 [tons & (ZAR)]	Baseline scenario [m^3 & ZAR)]	Scenario 2 [m^3 & ZAR)]	Scenario 3 [m^3 & ZAR)]	Scenario 4 [m^3 & ZAR)]
2008	13 473 (1 612 408)	19 405 (2 328 561)	30 495 (3 659 456)	30 495 (3 659 456)	164 082 (328 163)	296 038 (592 077)	541 266 (1 082 532)	541 266 (1 082 532)
2009	7 784 (934 046)	13 775 (1 653 001)	4 419 (530 290)	4 419 (530 290)	162 836 (325 672)	293 329 (586 658)	82 783 (165 566)	82 783 (165 566)
2010	7 751 (930 174)	3 658 (438 991)	475 (56 954)	475 (56 954)	180 213 (360 427)	85 476 (170 952)	14 010 (28 021)	14 010 (28 021)
2011	2 633 (315 924)	323 (38 704)	-155 (-18 602)	-155 (-18 602)	68 942 (137 884)	14 414 (28 829)	3 695 (7 389)	3 695 (7 389)
2012	6 093 (731 157)	4 555 (546 642)	4 431 (531 734)	3 235 (388 219)	146 521 (293 041)	109 375 (218 751)	106 604 (213 209)	80 161 (160 321)
2013	5 145 (617 365)	4 335 (520 222)	4 522 (542 687)	3 986 (478 369)	125 200 (250 399)	104 239 (208 477)	108 392 (216 784)	96 937 (193 875)
2014	3 659 (439 126)	3 461 (415 358)	3 978 (477 381)	4 438 (532 587)	92 208 (184 415)	84 622 (169 244)	96 003 (192 007)	106 804 (213 607)
2015	1 937 (232 411)	1 597 (191 634)	2 004 (240 449)	2 576 (309 120)	54 432 (108 864)	43 345 (86 689)	52 115 (104 230)	65 328 (130 657)
2016	1 895 (227 391)	1 572 (188 591)	1 986 (238 328)	2 563 (307 618)	54 432 (108 864)	43 339 (86 678)	52 114 (104 229)	65 328 (130 655)
2017	1 847 (221 619)	1 543 (185 122)	1 966 (235 894)	2 549 (305 897)	54 432 (108 864)	43 338 (86 677)	52 114 (104 229)	65 327 (130 655)
2018	1 792 (214 981)	1 509 (181 137)	1 942 (233 095)	2 533 (303 918)	52 114 (104 229)	65 327 (130 655)	52 114 (104 229)	65 327 (130 655)
2019	1 728 (207 348)	1 471 (176 555)	1 916 (229 877)	2 514 (301 642)	52 114 (104 229)	65 327 (130 655)	52 114 (104 229)	65 327 (130 655)
2020	1 655 (198 570)	1 427 (171 285)	1 885 (226 176)	2 492 (299 025)	52 114 (104 229)	65 327 (130 655)	52 114 (104 229)	65 327 (130 655)
2021	1 571 (188 475)	1 377 (165 226)	1 849 (221 920)	2 467 (296 015)	52 114 (104 229)	65 327 (130 655)	52 114 (104 229)	65 327 (130 655)
2022	1 474 (176 865)	1 319 (158 257)	1 809 (217 026)	2 438 (292 554)	52 114 (104 229)	65 327 (130 655)	52 114 (104 229)	65 327 (130 655)
2023	1 363 (163 514)	1 252 (150 243)	1 762 (211 397)	2 405 (288 574)	52 114 (104 229)	65 327 (130 655)	52 114 (104 229)	65 327 (130 655)
2024	1 235 (148 161)	1 175 (141 027)	1 708 (204 925)	2 367 (283 996)	52 114 (104 229)	65 327 (130 655)	52 114 (104 229)	65 327 (130 655)

2025	1 088 (130 505)	1 087 (130 428)	1 646 (197 481)	2 323 (278 732)	52 114 (104 229)	65 327 (130 655)	52 114 (104 229)	65 327 (130 655)
2026	918 (110 200)	985 (118 240)	1 574 (188 920)	2 272 (272 679)	52 114 (104 229)	65 327 (130 655)	52 114 (104 229)	65 327 (130 655)
2027	724 (86 849)	869 (104 223)	1492 (179 076)	2 214 (265 717)	52 114 (104 229)	65 327 (130 655)	52 114 (104 229)	65 327 (130 655)
2028	500 (59 996)	734 (88 104)	1 398 (167 755)	2 148 (257 711)	52 114 (104 229)	65 327 (130 655)	52 114 (104 229)	65 327 (130 655)
2029	243 (29 115)	580 (69 567)	1 289 (154 736)	2 071 (248 505)	52 114 (104 229)	65 327 (130 655)	52 114 (104 229)	65 327 (130 655)
2030	-53 (-6 399)	402 (48 250)	1 165 (139 764)	1 983 (237 917)	52 114 (104 229)	65 327 (130 655)	52 114 (104 229)	65 327 (130 655)

Source: Own analysis
Note: All numbers in brackets represent the values of potential carbon sequestration losses and water savings in South African Rand (ZAR).
* Units represented in quantity and (monetary values).
Note: Monetary values are shown in brackets whilst the physical quantities are not in brackets.

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