World Balance Architects
Game Mechanics Reference

Contents

1 The 8 Actions

1.1 Build Canal — Cost: 3 eco

- Converts a **Land tile** → **River tile**
- Must be placed **adjacent to an existing River or Reservoir**
- Sets `cell.water = 10.0` permanently
- **Effect**: Expands the water network, which spreads water to nearby cells. More water = higher Water meter = helps farms grow

1.2 Build Reservoir — Cost: 10 eco

- Converts **Land** → **Reservoir**
- Same placement rule as Canal (must be adjacent to water)
- Also sets `cell.water = 10.0` permanently
- **Effect**: Same as Canal but more expensive. Strategic value is the **score bonus** (+0.3 points per simulation step from asset scoring)

1.3 Plant Forest — Cost: 4 eco

- Converts **Land** → **Forest** (maturity = 0)
- Can be placed **anywhere on Land** — no water requirement
- Forests take **3 simulation steps per maturity level** to grow (0→1→2→3)
- **Effects per simulation step:**
  - Base oxygen: +0.2 per forest tile (regardless of maturity)
  - Bonus oxygen: +0.08 per maturity level (3 forests at maturity 3 = +0.72 extra)
  - Temperature cooling (context-sensitive):
    * Temp < 40°: **no cooling at all**
    * Temp 40–60° (optimal): maturity_sum × 0.05
    * Temp > 60°: maturity_sum × 0.10
    * Temp > 80°: maturity_sum × 0.20 (emergency doubling)
  - Water cycle: +0.05 per forest to the Water meter (transpiration)
  - Slightly reduces farming land area (farms warm the planet, forests cancel that)
  - Score: +0.2 × maturity per step

1.4 Clear Forest — Cost: 2 eco

- Converts **own Forest → Land**
- Immediately removes all oxygen production and cooling from that tile
- **Side effects (via simulation):**
  - Oxygen drops faster (one fewer forest producing it)
  - Temperature rises faster (one fewer cooling source)
- Only clears forests **you own** — cannot vandalize opponent's forests

1.5 Plant Farm — Cost: 3 eco

- Converts **Land → Farm** (crop_stage = 0)
- Requires **water access**: the cell itself OR any neighbor must have `water` ≥ 3.0
- **This is why you need Canals/Reservoirs first** — farms only work near water
- Crops grow: stage 0→1→2→3, advancing every **2 simulation steps** if water stays present
- **Effects of farms per simulation step:**
  - Water drain: -0.2 per farm (irrigation)
  - Slight oxygen drain: -0.05 per farm
  - Warms planet: $+0.1°$ per farm
  - Food production: only **mature farms (stage 3)** contribute +0.5 food/step × farm_efficiency
  - Score: +0.15 × crop_stage per step

1.6 Harvest Crop — Cost: 1 eco

- Can only harvest a **stage 3 farm you own**
- Instantly adds +15 food to the global Food meter
- Resets crop to stage 0 to regrow
- **Hard cap**: only adds food up to 85 (surplus spoils)
- Bonus: +2.0 score for the harvesting agent
- **Key mechanic**: This is your main way to rapidly fill Food. Passive farm production (+0.5/step) is slow — harvesting gives a 15-point burst.

1.7 Build Solar Plant — Cost: 8 eco

- Converts **Land** → **Solar Plant**
- No placement restriction (any Land tile)
- **Effects per simulation step:**
  - Eco income: +1 eco per solar per step (main reason to build them)
  - Temperature: +0.4° per solar plant ← **this is dangerous**
  - Oxygen: −0.1 per solar (industrial consumption)
- **Trade-off**: More eco income but heats and de-oxygenates the planet. 3 solar plants alone = +1.2°/step.

1.8 Adjust Resource Allocation — Cost: 0 eco (free)

- Sets your agent's priority mode: `farm`, `forest`, or `balanced`
- No tile changes
- Used by AI agents to signal their strategy to their own logic
- Valid anytime, always available

2 How Actions Affect Each Other (Chain Reactions)

```
Build Canal/Reservoir
    -> water spreads to nearby cells (WATER_DECAY = 1.5 per cell)
        -> Plant Farm becomes valid on those cells
            -> Farms grow crops (needs water >= 3.0 every step)
                -> Harvest Crop -> +15 Food burst
                -> Meanwhile farms drain water (-0.2/farm/step)
                    -> If too many farms, water drops -> crops stall

Plant Forest
    -> produces oxygen (+0.2/forest + maturity bonus)
    -> cools temperature (context-sensitive)
    -> adds moisture (+0.05/forest to water cycle)
    -> conflicts with solar: forests cool, solar heats -> balance

Build Solar Plant
    -> heats planet (+0.4 deg/solar)
    -> if temperature rises above 65 deg:
        -> farm_efficiency drops to 0.7 (crops produce 30% less food
           )
        -> if above 75 deg: farm_efficiency drops to 0.4
        -> population starts losing health
```

```
    -> earns +1 eco/step (more actions available)

High Water (>80)
    -> flood_drain kicks in (-0.15 * excess per step)
    -> if water > 85: farm_efficiency * 0.6
    -> if water > 92: farm_efficiency * 0.35 (near total crop
       failure)
```

3 The 4 Global Meters

3.1 Water Level (0–100, optimal: 50–80)

Source	**Effect**
Each River tile	+0.3/step
Each Reservoir	+0.3/step
Each Forest	+0.05/step (transpiration)
Each Farm	−0.2/step (irrigation drain)
Population	$-(\text{pop} \times 0.01)$ minimum/step
Passive evaporation	−0.6/step always
If water > 80	extra drain: $(\text{water} - 80) \times 0.15$
If temp $> 70°$	extra drain: $(\text{temp} - 70) \times 0.06$

3.2 Food (0–100, optimal: 50–80)

Source	**Effect**
Mature farm (stage 3)	+0.5/step × farm_efficiency
Harvest Crop action	+15 instantly (max up to 85)
Population eating	$-(\text{pop} \times 0.04)$ minimum/step
Overpopulation (> 100)	eats even more per capita
Food > 72	spoilage: $(\text{food} - 72) \times 0.30$/step

Farm efficiency modifiers:

- Temp $> 75°$: $\times 0.4$
- Temp $> 65°$: $\times 0.7$
- Water > 92: $\times 0.35$ (also applied)
- Water > 85: $\times 0.6$ (also applied)

3.3 Oxygen (0–100, optimal: 50–80)

Source	Effect
Each Forest	+0.2/step
Each Forest (maturity bonus)	$+0.08 \times$ maturity/step
Each Farm	-0.05/step
Each Solar Plant	-0.1/step
Population breathing	$-(\text{pop} \times 0.04)$/step (reduced when $O_2 < 40$)
Passive atmospheric drain	-0.3/step always
Temp > 65°	heat decomposition: $(\text{temp} - 65) \times 0.06$ drain
Oxygen > 80	bleeds off: $(\text{oxy} - 80) \times 0.65$/step
Oxygen > 85 + forests	wildfire drain: $(\text{oxy} - 85) \times \text{forests} \times 0.04$

3.4 Temperature (0–100, optimal: 40–60)

Source	Effect
Passive greenhouse	+0.5°/step always
Each Farm	+0.1°/step
Each Solar Plant	+0.4°/step
Oxygen > 80	oxidation heat: $(\text{oxy} - 80) \times 0.04$
Population > 100	human activity heat: $(\text{pop} - 100) \times 0.005$/step
Forests (temp > 60°)	$\text{maturity\_sum} \times -0.10$/step
Forests (temp > 80°)	$\text{maturity\_sum} \times -0.20$/step (emergency)
Water cells on grid	-0.01 per water-covered cell
Temp > 80°	radiates heat: $(\text{temp} - 80) \times 0.175$ (self-regulation)

4 How Population Works

Population lives in the range **5 to 200**.

It grows when:

- Food > 50 (base growth = $(\text{food} - 50) \times 0.08$)
- All 4 meters in optimal range → extra +0.4/step
- Decent conditions → extra +0.2/step
- Logistic brake: growth slows as you approach 200 — $\times(1 - \text{pop}/200)$

It declines when:

- Oxygen < 25: -2.5/step (suffocation)
- Oxygen < 40: -0.8/step
- Temp > 75°: -2.0/step

- Temp $> 65°$: -0.8/step
- Water < 15: -1.5/step (drought)
- Water < 30: -0.6/step

Population in turn feeds back into the meters:

- Drinks water, eats food, breathes oxygen every step
- Above population 100: `overload_factor` increases per-capita consumption by up to 50% at pop$=200$
- Above population 100: adds cumulative warming $+0.005°$/step per person above 100

The cycle:

```
Good food -> pop grows -> pop eats more food -> food drops
                      -> pop breathes more oxygen -> oxygen drops
                      -> pop drinks more water -> water drops
                      -> high pop generates heat -> temp rises
                            -> crops fail -> food collapses -> pop
                               crashes
```

5 What Happens at Extreme Values

5.1 Water at 0

- No farms can grow (no water access)
- Population takes drought penalty: -1.5/step if < 15
- Planet becomes a desert — game spirals fast

5.2 Water at 100 (flooding)

- `flood_drain` removes water fast: $(100 - 80) \times 0.15 = -3$/step (self-correcting)
- Farm efficiency $\times 0.35$ (near total crop failure)
- Food collapses even if you have many farms

5.3 Food at 0

- Population shrinks rapidly (no food = starvation)
- Pop drop reduces resource consumption which gives a partial recovery window

5.4 Food at 100

- Spoilage: $(100 - 72) \times 0.30 = -8.4$/step (rapid self-correction)
- Hard cap at 85 enforced on harvests

5.5 Oxygen at 0

- Population: -2.5/step (suffocation crisis)
- Essentially unrecoverable without urgent forest planting

5.6 Oxygen above 85

- Wildfire drain: proportional to forest count — **ironically, having many forests when oxygen is too high makes it drain faster**
- This discourages pure oxygen stacking

5.7 Temperature above 80

- Heat radiation kicks in: $(\text{temp} - 80) \times 0.175$ (passive self-correction, but slow)
- Forest emergency cooling doubles: maturity_sum $\times 0.20$
- Pop: -2.0/step, farm efficiency $\times 0.4$, heat evaporation worsens water drain
- Game becomes a crisis requiring heavy forest planting

5.8 Temperature below 40 (cold)

- Forest cooling is disabled (forests don't cool when it's already cold)
- Passive greenhouse $+0.5°$/step will slowly warm it back up
- Rarely a real danger since solar and farms constantly generate heat

6 Scoring

Every simulation step (every turn):

1. **Both agents** get stability $\times$ 1.0 points — shared reward for keeping the planet healthy
2. **Individual asset scoring:**
   - Forest: $+0.2 \times$ maturity/step
   - Farm: $+0.15 \times$ crop_stage/step
   - Reservoir: $+0.3$/step
   - River (owned): $+0.1$/step

3. **Harvest bonus**: +2.0 immediately when you harvest

Planet stability is the average of how close all 4 meters are to their optimal ranges — so both agents are incentivized to keep the planet balanced, even while competing for territory.