**Case Study – Ethical Multi-Agent Simulation (Water Allocation)**

### **📚 Project Overview**

This simulation explores how multiple agents (villages) can ethically share a limited natural resource — **water** — by making decisions influenced by **priority**, **fairness**, and a unique **karma-based consensus mechanism**.

This aligns with SoulMindFusion's goal to embed harmony, responsibility, and ethical intelligence in AI systems.

### **⚖️ Ethical Objectives**

* Agents must **not compete greedily** for water
* Fair allocation prioritizes need, seniority, and prior sacrifice
* Karma is used to reward agents who act selflessly

### **🔧 Technologies Used**

* Python (simulation engine)
* JSON logging per round
* Sorting logic based on priority ➕ karma ➕ need

### **📊 Simulation Workflow**

| **Step** | **Description** |
| --- | --- |
| 1 | Define agents with needs, priorities, and karma tracking |
| 2 | Set up environment with limited water (e.g., 100L) |
| 3 | Sort agents using ethical logic: priority → need → karma |
| 4 | Allocate water fairly (no one gets more than needed) |
| 5 | Update karma: sacrifices increase it, greed reduces it |
| 6 | Repeat over multiple rounds with karma carried forward |

### **✨ Karma Logic**

| **Scenario** | **Karma Change** |
| --- | --- |
| Agent sacrifices completely (0L) | +2 |
| Agent accepts less than needed | +1 |
| Agent takes exactly what is needed | 0 |
| Agent receives more than needed | -1 |

### **📅 Sample Outcome (Round Log)**

Village A ➤ Requested 40L, Received 35L, Karma +1

Village D ➤ Requested 25L, Received 25L, Karma +0

Village C ➤ Requested 50L, Received 30L, Karma +1

### **⚠️ Challenges & Fixes**

| **Challenge** | **Fix** |
| --- | --- |
| Tie-breaking in priority | Used karma score to break ties ethically |
| Looping over multiple rounds | Karma state carried across rounds |
| Over-allocation detection | Min(request, remaining) to prevent greed |

### **🌌 Outcome**

* Ethical agents evolved over 3 rounds
* Greedy behavior reduced with karma logic
* Log files created per round for auditing and explainability