José Benito de Andrade Vieira

# Adaptation to climate change in irrigated agriculture: An evolutive water footprint approach.

Campina Grande - PB February, 2020

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Dissertation presented to the Graduate Program in Civil and Environmental Engineering in compliance with the requirements to obtain the Master's Degree.

Federal University of Campina Grande - UFCG Graduate Program in Civil and Environmental Engineering

Supervisor: Carlos de Oliveira Galvão Co-supervisor: Érica Cristine Medeiros Machado

> Campina Grande - PB February, 2020

V658a Vieira, José Benito de Andrade. Adaptation to climate change in irrigated agriculture: an evolutive water footprint approach / José Benito de Andrade Vieira. - Campina Grande, 2020. 167 f. : il. color. Dissertação (Mestrado em Engenharia Civil e Ambiental) -Universidade Federal de Campina Grande, Centro de Tecnologia e Recursos Naturais, 2020. "Orientação: Prof. Dr. Carlos de Oliveira Galvão, Prof. Dr. Érica Cristine Medeiros Machado". Referências. 1. Recursos Hídricos. 2. Otimização Sequencial. 3. Gestão Adaptativa. 4. Agricultura Irrigada. 5. Equidade. I. Galvão, Carlos de Oliveira. II. Machado, Érica Cristine Medeiros. II. Título. CDU 631.37(043) FICHA CATALOGRÁFICA ELABORADA PELA BIBLIOTECÁRIA SEVERINA SUELI DA SILVA OLIVEIRA CRB-15/225

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Este trabalho é dedicado aos meus pais, Benedito e Raimunda, pelo apoio incondicional em todos os momentos da minha vida.

# Acknowledgements

Primeiramente a Deus, pela vida que tenho, pela saúde que nunca faltou, pela força de correr atrás dos meus objetivos, pelas oportunidades colocadas no meu caminho, por errar e poder tentar novamente e, acima de tudo, pela paz.

Aos meus pais e familiares, por terem me ensinado a ser tudo que eu sou hoje e pelo apoio, carinho e dedicação que me foram dados.

Aos meus orientadores, Carlos e Érica, pela paciência de me explicar aquilo que eu não compreendia (muitas vezes mais de uma vez), pela sempre disponibilidade de me orientar, pela humildade de repassar seu conhecimento e pela modéstia com que conversavam com os alunos na hora do café.

Aos meus colegas do Laboratório de Hidráulica II (a.k.a. BU), pelo apoio, pelas trocas de conhecimento e pelos momentos de descontração que vivemos juntos ao longo deste dois anos de mestrado.

Aos professores e funcionários do Programa de Pós Graduação em Engenharia Civil e Ambiental, pela qualidade dos serviços prestados e pela disposição em compartilhar todo este vasto e precioso conhecimento que lhes é tido.

A CAPES, pelo financiamento desta pesquisa.

A todos aqueles que não foram mencionados diretamente, mas que, de alguma forma, contribuíram para a realização este trabalho.

Muito Obrigado!

"isso de querer ser exatamente aquilo que a gente é ainda vai nos levar além" (Paulo Leminski)

## Resumo

Em um cenário global em constante alteração devido às mudanças climáticas, surge a necessidade de se melhorar a maneira como usamos os nossos cada vez mais escassos recursos naturais. Como a agricultura é o setor produtivo que consome mais água no mundo, esta torna-se um foco prioritário destes esforços. Muitos trabalhos já apontaram quais seriam as melhores medidas de adaptação aos impactos das mudanças climáticas na agricultura, porém pouco se sabe sobre quais são as melhores maneiras de implementar essas medidas, especialmente quando se inclui nesta problemática variáveis como: limitações financeiras, disparidades de poder entre grandes e pequenos agricultores, e perdas de produtividade devido à diminuição da disponibilidade de água. Este trabalho objetivou desenvolver uma metodologia para determinar estratégias ótimas de adaptação para o uso da água na agricultura irrigada, utilizando a pegada hídrica como indicador de eficiência/sustentabilidade para guiar o processo. O SPEA2, um algoritmo evolutivo de segunda geração, foi usado para encontrar soluções ótimas, enquanto o software Aquacrop OS foi usado para estimar a pegada hídrica de cada agricultor. Com isso, é possível determinar um conjunto de soluções ótimas de Pareto, a partir dos dois principais objetivos deste processo de adaptação: aumentar a eficiência/sustentabilidade do uso da água e minimizar o custo para fazer isso. A estratégia de adaptação, segundo a metodologia proposta, é gerada em várias etapas, de maneira que a mesma importância é dada aos estágios intermediários e ao resultado final do processo. Com o objetivo de testar a metodologia desenvolvida, um caso de estudo prático foi realizado, utilizando como exemplo a Bacia do Rio Mamuaba (uma sub bacia da bacia do Rio Gramame), localizada no estado da Paraíba, nordeste do Brasil. Para o caso de estudo, observando-se todas as fronteiras de Pareto obtidas no processo, algumas recomendações gerais puderam ser extraídas para os agricultores. Nas primeiras décadas, até um certo custo, a redução na pegada hídrica por unidade de dinheiro investida é mais proveitosa do que além desse ponto, enquanto no final do período de adaptação é melhor escolher medidas mais baratas. Também foi sugerido fazer mais alterações que aprimoram a eficiência do sistema do que alterações que substituem diferentes tipos de culturas. Pequenos agricultores foram priorizados no processo de adaptação, tornando a abordagem mais holística. Também foram sugeridos valores de referência de Pegada Hídrica com o objetivo de servir como metas de redução para orientar e ajudar a monitorar o processo de implementação da estratégia de adaptação no campo.

Palavras-chave: otimização sequencial; equidade; gestão adaptativa.

# Abstract

In a rapidly changing global scenario due to climate change, there is a need to improve the way we treat our increasingly scarce natural resources. As agriculture is the most waterconsuming productive sector in the world, it becomes a priority focus on these efforts. A lot of works had pointed out what are the best adaptation measures to climate change impacts on agriculture, however little is known about what are the best ways to implement these measures, especially when are included in the problem variables such: financial limitations, power gaps between large and smallholder farmers, and losses in productivity due to decreases in water availability. This work aims to develop a methodology to determine optimal adaptation strategies for water use in irrigated agriculture using the water footprint as an efficiency/sustainability indicator to guide the process. SPEA2, a second-generation evolutionary algorithm, was used to find optimal solutions, and Aquacrop OS was used to estimate the farmer's water footprint. Through this, it is possible to determine a set of Pareto solutions with the two main objectives of the adaptation process: increase water use efficiency/sustainability and minimize the cost to do so. The adaptation strategy is generated in several steps, in a way that the same importance is given to the mid rages and the final result of the process. To test the develop methodology, a practical study case was simulated using River Mamuaba basin (a sub basin from River Gramame basin), located in the Paraiba state in northeast Brazil. For the study case, observing the Pareto frontiers for all decades, some general recommendations could be extracted to the farmers. For the firsts decades, until a certain cost, the reduction in water footprint per unit of money invested is more gainfull than beyond that point, while at the end of the adaptation period, it is better to choose cheaper measures. It was also suggested to make more changes that enhance the system's efficiency than changes that replace different kinds of crops. Very small and small farmers were prioritized in the adaptation process, making the approach more holistic. Water Footprint benchmarks are also suggested to serve as reduction targets to guide and helps to monitor the adaptation strategy implementation process on the ground.

Keywords: sequential optimization; equity; adaptative management

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# 1 Introduction

#### 1.1 Problem

Climate change has been cited by ??) as a phenomenon of relevant importance in short and long term projections. Projected variations are mainly associated with an increase in temperatures and a decrease in average rainfall. In addition, there is also a high probability of intensification of extreme events, such droughts. This conjuncture emphasizes the need to take measures to address the risks related to climate change, taking into account the scale of the analysis and the local particularities (??).

In recent decades, a large number of studies have indicated that rural areas are particularly vulnerable to climate change, that is because plant growth can be severely affected by rising temperatures and decreasing rainfall, compromising agricultural production and food security both globally and locally (??). According to ??), for each degree increased in the historical average temperature, a decrease of 5 % in agricultural production is expected. Still according to the same authors, crops that have undergone some measure of adaptation to climate change have a yield about 7 % higher than non-adapted ones. For this reason, maintaining the sustainability of this sector in an ever-changing scenario has become a staple on the agenda of farmers, politicians, and government agencies (????).

Householders farmers living in underdeveloped countries are the most vulnerable to these impacts. For this group, even small changes in climate can result in disastrous impacts on their lives and livelihoods. The main aggravating factors are: unfavorable geographical positions, low income, high dependence on agriculture for subsistence, and limited ability to look for alternative forms of livelihood (??). In this context, considerable effort has been made to determine what are the best ways to adapt to future climate conditions, taking into account all uncertainties associated with climate projections (???). Speaking of agriculture in particular, several adaptation strategies have been proposed by several authors, among them: increase water use efficiency, increase soil water retention capacity, and biodiversity (????????).

In addition to these, more specific strategies have been proposed. ??) studied the main crops of Central Europe and suggested better agricultural management and genetic improvement as ways to confront climate change. ??) used a multi-purpose genetic algorithm to generate climate resilient land use compositions. ??) has created a three-step adaptation strategy for an agricultural area in sub-Saharan Africa, where for each location and each time period one type of adaptive measure would be most appropriate. ??) studied the relationship between adaptation strategies, food security, agricultural production and the type of production (subsistence, diversified, extensive or intensive). The conclusion was that, depending on the type and size of the producer, different adaptation strategies are more appropriate.

After analyzing several papers related to this theme (including those already mentioned above), it was possible to realize that the main focus of these is, in the vast majority of cases, the determination of what measures can be taken to make a region less vulnerable to the effects of climate change, hence little was said about how these measures would be implemented (the transition process) on the ground. Taking into account the information mentioned above, one of the innovations that this work aims to present refers to the focus that is given to the elaboration of an optimized transition process between the current state of a given region and the so-called ideal state (a state that is adapted to the impacts of climate change), caring about the transition process as much as its the end result. Besides that, when looking for the best ways to adapt, the factors listed below are taken into account:

- Budgetary limitations, which indirectly dictate what action can be taken and the speed with which it will happen.
- Mixed groups of farmers, ranging from small families who see agriculture as their livelihood to large intensive farming, where a clear power difference can be identified between the parties.
- Loss in production due to decreased water availability coupled with the impossibility of applying an adaptive measure in a timely manner.

Thus, this work proposes to answer the following questions: What must be done so that the adaptation process occur as best as possible, considering local financial constraints? Is it possible to maintain equity during this whole process since there are such power asymmetry involved? What is the most appropriate (cost-effective) adaptation strategy that compensates for the reduction in water availability (over a certain period of time) and does not undermine farmer's production? What goals can be set to assess whether adequate effort is being employed in adopting such measures over time?

It is critical to be concerned about the applicability of the adaptation measures from the point of view of those who will apply them if they are ever expected to come out of paper and become a reality, as the negative impacts of climate change are already occurring.

#### 1.2 Proposed Solution

There are two main ways to deal with decreasing water availability. The first would be to reduce cultivated area, which would not require any other measure, but which, on the other hand, would reduce food production, a fact that should be avoided as much as possible. The second way would be to increase water use efficiency, which would not require a reduction in the cultivated area, but which, on the other hand, would incur extra costs for the farmer, who would have to modernize his irrigation and soil management system. It is also possible to employ both strategies together.

What will determine in practice which strategy is going to be employed is the amount of money available to invest. In an utopian scenario with unlimited funding and unlimited technology, no reduction in productivity would be required and all adaptation would be done by increasing system's efficiency. In a real scenario, where funding and technology is limited, especially in developing countries like Brazil, it is not always possible to do this.

Therefore, it is essential to optimize the decision-making process so that the limited money is spent in order to produce the best outcome, so that the impact of climate change on agricultural production is minimal. Besides cost and productivity, it is essential to consider the social aspect as well. The adaptation strategy should, in addition to fulfilling the objectives mentioned above, favor the adaptation of small farmers, because, as we have seen, they are the most vulnerable.

Assuming that the available budget for adaptation is finite and renewable over time and knowing that climate change is a dynamic phenomenon and will continue to affect the planet's climate for several decades, the adaptation strategy has been subdivided into several stages (or steps), each step is product of an independent optimization process, so that the adaptation strategy can change over time, adjusting to the dynamic aspect of the process. The evolutionary approach of the adaptation strategy proposed by the suggested methodology can be seen as another innovation of this research, since none of the papers researched in this works presented an approach similar to what was done in this work. Due to the progressive aspect of the adaptation strategy, it will be possible to establish sustainability goals to be achieved over time. These goals will serve as a means of monitoring and evaluating if the adaptation strategy is being effectively implemented on the ground. It is necessary to make it clear that the main objective of this work is to propose a generic methodology for the generation of adaptation strategies for different cases and locations around the world. At the end of the work, the methodology developed was applied to a local case study, with the aim of demonstrating the performance of the method in concrete case.

To guide the optimization process it is necessary to quantify the sustainability/ef-

ficiency of the system, in order to aim for the highest efficiency increases at the lowest costs. In the literature there are a large number of indicators that could serve to this purpose, among them, this research proposes to use the water footprint, due to its use in other works as an aid in the decision making process (??) and as a tool to encourage the replacement of less efficient methods by more efficient ones (??).

The optimization method used in this work was a type of evolutionary algorithm known as genetic algorithm. This method was chosen due to several factors. In general, these algorithms can work very well together with other models, since they use only objective function's information and suitability of the solutions; They are also highly capable of optimizing objective functions with complex surfaces, reducing problems related to convergence to local minimum points, are less susceptible to the shape or continuity of the Pareto Frontier, and are simpler to impose qualitative constraints (??).

The genetic algorithm, like most multiobjective methods, uses Pareto's dominance concept, which is the search not only for a single optimal solution but for a set of favorable solutions for all goals. According to ??) Pareto's optimal solutions are those in which one goal can only be improved by causing a simultaneous worsening to another, and that are better than the others in at least one goal. Through the Pareto optimality concept a set of optimized solutions can be determined, which can serve as scenario options. This opens the possibility of having a meeting between the farmers participants in the process to define, in a participatory way, which option is the most advantageous for the group. Since all options results from a optimization process, they are all able to solve the adaptation problem in different ways.

# 2 Objectives

#### 2.1 General Objective

Determine medium to long-term adaptation strategies for increasing water use sustainability of a group of farmers that shares the same water source.

#### 2.2 Specific Objectives

- Assess whether that strategies contribute positively or negatively to mitigate the power and opportunity differences that exist between small and large farmers.
- Identify through the adaptation strategies general recommendations to be followed by the farmers
- Set sustainability goals based on local characteristics, which could serve for monitoring and evaluating the implementation of adaptation strategies on the ground.

# 3 Literature Review

### 3.1 The History of Environmental Issues and the Decision Making Process in Environmental Management

Since the 1960s, environmental issues were evident and caused concern among state leaders and the scientific community. In the following years, this concern only increased due an increasing number of disasters and the worsening of environmental imbalances. This fear for the worrisome future of the planet motivated the first global environmental conference, known as the Stockholm Conference, held in 1972 in Stockholm, Sweden. It was considered an international political milestone, as it has played a decisive role in directing the world's eyes to environmental issues and, consequently, enabling the emergence of environmental management policies (??).

In 1974 a meeting between UNCTAD (United Nations Conferences on Trade-Development) and UNEP (United Nations Environment Program) resulted in Cocoyok's statement, which contributed to the discussion about the relationship between the level of development of countries and the environment. Among the conclusions of this meeting there as: 1) Environmental destruction is caused, among other factors, by poverty, which leads the needy population to overuse the soil and native vegetation; 2) There is not only a minimum of resources necessary for the welfare of an person; there is also a maximum (??).

In 1975, the final report of a Dag-Hammarskjöld Foundation project involving researchers and politicians from 48 countries was presented, reinforcing and deepening the points presented at Cocoyok. This report shows the relationship between power abuse and ecological degradation. In it is possible to see how the colonial system concentrated the most suitable soils for agriculture in the hands of a social minority, while the large mass of the original population was expelled, marginalized and forced to use lower quality lands. This has devastated many landscapes in South Africa, Morocco, and many other locations (??).

Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs. This concept of sustainable development was first introduced to the world in 1987 with the publication of "Our Common Future Report" by the World Commission on Environment and Development(WCED) (??).

In 1992, in Rio de Janeiro took place the Earth Conference, also known as Eco-92,

where sustainable development was recognized as a goal to be pursued by all nations. This conference gave rise to Agenda 21, a document that systematizes an action plan that has been helping many country to achieve a more sustainable development and to improve environmental and life quality of the population (??).

After these, other meetings were held and other environmental documents were published to discuss and reaffirm the commitment to sustainable development. These include the Earth Charter (in Paris in 2000), the Johannesburg Declaration (in South Africa in 2002) and the Rio +20 (in Rio de Janeiro in 2012).

It is important to present this background to show how the concern with sustainability and sustainable development has grown and become more relevant to national leaders over the years. It is important to mention as well, however, that the decisionmaking process in environmental management is complex, interdisciplinary and fraught with uncertainty, especially when considering climate change scenarios (??).

To deal with these complexities and uncertainties, it is important that the approaches developed to assist in the decision-making process are multidisciplinary and allow the participation of all parties involved (??). According to ??), social participation is essential for solving unstructured (climate change and adaptation) or moderately structured problems, although less necessary for well-structured problems.

??) recognizes that the lack of articulation between stakeholders is still a reality in natural resources management, constituting the biggest obstacle for sustainable development. The same author also points out that collaborative management is essential to deal with complex problems.

Organizations must adapt to cope with change, since this changes can become a serious problem if not addressed properly. Many organizations are unable to adapt efficiently or quickly enough due to its stifled standards, institutional arrangement and governance. ??) presents the concept of adaptive governance, which aims to increase an organization's ability to adapt to change. Adaptive governance strategies include utilizing internal and external resources, decentralizing the decision-making process, and seeking to convey decision-making information bottom-up.

#### 3.2 Climate Change and its Implications for Water Availability

Global warming continues to dominate the global political and scientific agenda, mainly due to the changes it is causing in the behavior of the various planet's ecosystems. Water's vapor saturation pressure in the atmosphere is highly sensitive to temperature, so it can be said that the warming of the planet causes changes in the water cycle. Imbalances in the hydrological cycle will reflect in rainfall and river flow on many parts of the world, where will be expected an increase in some places and decrease in others (??).

A key concern is the impact of climate change on global water availability. Studies such as ??) already pointed, a few decades ago, that a significant portion of the population was already living in areas where there was water deficit and that this situation would only worsen in the future, mainly due to global warming and increasing water demands.

According to ??), between 1.6 and 2.4 billion people currently live in river basins that suffer from water scarcity. According to these authors, by 2050, it is estimated that this range will increase to between 0.5 and 3.1 billion due to climate change. Another important conclusion from this study is that in the future the world will see more areas entering in water scarcity scenarios than getting out of them.

Other studies also reveals that climate change will cause an increase in the demand for water, especially in the agricultural sector. As irrigation accounts for the biggest part of the global water consumption, an increase in the water demand of this sector can cause severe stress on water resources. Just proper management of the water sources will not be enough to adapt to this new reality, water management on the demand-side is also needed in order to adapt to this new uncertain and constantly changing environment (??).

??) shows the consequences that global warming will provoke on irrigated agriculture. According to them, in some regions of the United States, China and Asia, it will be necessary to convert between 20 - 60Mha from irrigated crops to rainfed crops by the end of the century. This will represent a loss of between  $600 - 2900Pcal^{-1}$  in agricultural production.

In China, over the past decade, global warming is estimated to have caused a loss of about 820 million in the maize and soybean sectors. In addition, the production of these two sectors are expected to fall between 3 - 12 % and 7 - 19 %, respectively, by the year of 2100, for the same reason (??).

#### 3.3 Climate Change Adaptation

There are two main ways for society to respond to the consequences of climate change: Mitigation or adaptation. Mitigation means reducing the impacts caused by climate change through the reduction of greenhouse gases emissions, ie by addressing the problem directly at its source. Adaptation means acting on a particular vulnerable system in response to current or projected climate change in order to minimize the impact on this system, ie dealing with the symptoms of the problem (??).

Mitigation has received far more attention than adaptation, both politically and scientifically. That is because mitigation, by focusing on addressing the cause of the

<sup>&</sup>lt;sup>1</sup>  $\overline{Pcal: \text{Peta Calories}, 1Pcal \text{is equals to} 10^{15}}$  Calories

problem, reduces the impacts of climate change everywhere, including the locations where adaptation is hard to implement due to local constraints. In addition, greenhouse gas emissions are easier to be monitored quantitatively than the effectiveness of an adaptive measure, in terms of future impacts avoided (??).

Despite the obvious need for mitigation, there are also good arguments for the adoption of adaptive measures. Firstly, greenhouse gas emissions are already affecting climate conditions, meaning that mitigating measures will not soften the impacts that are already happening (??). Secondly, climate will continue to change in the near future, due to the accumulation of greenhouse gases and the inertia of the climate system (??). Thirdly, the effect of reducing greenhouse gas emissions will take decades to produce concrete results, while adaptive measures pay off in a much shorter period. Fourthly, adaptation can be implemented on a local/regional scale, making its effectiveness less dependent on external actions (??).

Adaptation and mitigation are not mutually exclusive alternatives, on the contrary, these are complementary to each other. This is because their have distinct characteristics, timescales and steakholders.

According to ??), the process of planning climate change adaptation strategies is the act of using current and future climate information to review the appropriateness of current practices, policies and structures. Planning adaptation strategies involves asking questions such as: How do climatic and non-climatic conditions of the future differ from those of the past? Do these changes interfere in the current decision making process? What is the ideal balance between the risks of acting too soon or too late? The process of adaptation comes down to making recommendations about what should be done more, less or different, and with what resources it will be done.

According to ??) and ??) the process of adaptation to climate change has several key dimensions, which are as follows:

- Climate Sensitive Domains: Adaptation is relevant to all climate related domains. (Agriculture, forestry, water management, public health, disaster prevention, etc.)
- **Types of climate disasters:** Adaptation can be motivated by several types of climate disasters, the ones that are already occurring or the ones that will occur in the future.
- **Predictability of climate change:** Some aspects of climate change can be predicted with a reasonable degree of confidence (eg variation in average temperatures), while others have a high degree of uncertainty in their prediction (eg changes in routes and intensity of hurricanes).

- Conditions not related to the weather: The adaptation process should not only consider the variables related to climate, but also the environment, politics and culture of the place where it is being implemented.
- Intentionality: Adaptation can be autonomous (when individuals act individually without an upper control over them) or intentionally planned (when there is institutional control over the measures being taken).
- **Time:** Adaptation can be reactive (happens after impacts occurrence) or proactive (when the adaptation is done before major damages occurs).
- **Planning horizon:** The adaptation planning horizon can vary substantially, from a few months to several decades.
- Form: The adaptation process is interdisciplinary and involves technical, institutional, legal, educational and behavioral measures. Research and data collection can also be considered adaptive measures (in a general context) as they facilitate the implementation of effective actions to reduce climate risks.
- Actors: Adaptation involves a large number of people of different hierarchical levels, as well as various public and private institutions.

Based on the work of ??), ??) suggested some prerequisites for climate change adaptation to be effective. The following list presents these prerequisites and what should be done to achieve each one:

- Be aware of the problem: Measuring vulnerability to climate change.
- Availability of adaptation measures: Encouraging researches that leads to the development of new adaptation options.
- Information about these measures: Identifying and measuring the effectiveness of adaptive measures.
- Availability of resources to implement these measures: Assessing the benefits of adaptation, identifying ways to increase resource efficiency, and provision of additional resources.
- Cultural acceptance of these measures: Informing people about the risks and about the adaptation measures to increase the acceptability of unfamiliar measures.
- Incentives for the implementation of these measures: Identifying obstacles to the implementation of effective measures and suggesting options for overcoming these obstacles.

As mentioned earlier, the process of designing and implementing policies that aims to reduce vulnerability to climate change involves a large number of people from different ranks. For ??), the participation of the following groups is essential to the success of this process:

- Scientists: Scientists produce essential knowledge, which shows us why current policies, practices and infrastructures are no longer appropriate for the future.
- **Professionals:** These are the people who really implement the recommended changes. They can provide information on how things are currently being done and why they are done in that way. This information is the starting point for planning change.
- **Decision makers:** Leaders of government agencies, business managers and other decision makers are critical parts to the adaptation process. They are the people who define what are the priorities and who decide which measures will be implemented and which not.
- Analysts: Political analysts and economists can help to choose which adaptation measures are priorities based on a cost-benefit analysis or any other criteria defined by decision makers.

Due to resource constraints, in some cases, adaptive measures can not be implemented immediately and a slower adaptation process is therefore required. Several authors have identified criteria for prioritizing adaptation measures (???????). There is an general agreement that anticipating adaptation is particularly favorable if:

- There is urgency for risk mitigation.
- There is a assurance that these risks will increase in the future (with high degree of reliability).
- Future impacts are potentially catastrophic or irreversible.
- Decisions have long-term effect.
- The adaptation takes a long time to be implemented and start to produce results.

In contrast, delaying the adaptation process may be viable if:

- Current and future risks are moderate.
- The adaptation process is very expensive.
- Options that produce quick responses are evaluable.

#### 3.4 Adaptation Strategies for Agricultural Water Management

Agriculture is the most water consuming sector in the world. Conducting water management for this sector is becoming an increasingly complex work, as now this must be done within the context of the progressive reduction of water availability. On the past years, several studies have been conducted to identify the main impacts caused by climate change on agriculture, as well as what would be the most appropriate measures to be taken to adapt to this new scenario (??).

The implementation of adaptive measures should vary according to local conditions. For example, in areas where there is significant economic and social inequality and water scarcity has not become a matter of urgency yet, water management should focus primarily on ensuring equal access to water (??).

Interventions should be made not only on the supply side, but also on the demand side. On the supply side, changes can be made to increase reservoir storage capacity or to find alternative water sources. On the demand side, what can be done is to prioritize the allocation of water to sectors that use it most efficiently (????). Science has to adapt as well, more multidisciplinary approaches needs to be done in order to deal with multidisciplinary issues; science also have to strengthen the comunication with decision makers (??).

An optimistic future will depend on whether agriculture will be able to consume water on an sustainability way or not. This will depend on a set of actions that may not produce results in the short-term. Ensuring economically efficient water use and promoting water and soil conservation are the priority areas of action (??).

Even when policies are well defined, user's training and/or orientation is required. For example, improving the efficiency of irrigation methods is only an option for groups that already have a certain understanding of what alternative technologies are and how important are to implement these in practice (????).

Implementing adaptive measures can be challenging for both farmers and managers. In the short term, cultural and financial barriers may limit adaptation to the adoption of low cost and ease to implement measures. Long-term measures that requires changes in infrastructure, technology or governance are more difficult to implement (??).

??) evaluated various types of adaptation strategies for agricultural water management. As a result, the authors were able to summarize what are the main objectives that the adaptation process should achieve, the main adaptive measures that can be used to achieve these objectives, and the main mechanisms to address the impacts of climate change. This information can be viewed in the Figure ??.

In irrigated agriculture, a change in an irrigation method can cause a significant reduction in water footprint and ,thus, in water consuption. Using dripping irrigation instead of sprinkler irrigation can result in a water savings of over 30 % (??). According to ??) drip technology could reduce the total water footprint by 5%, when compared to sprinkler. According to ??) China's average water footprint per ton of wheat under sprinkler irrigation was 21% higher than that under micro-irrigation in 2014. Improving the irrigation efficiency has been identified as a major strategy to adapt to future climate and socioeconomic change globally and in major arid regions (???????). However, more efficient irrigation is only one aspect of adaptation to global change, others improvements are necessary to ensure food security and mitigates impacts in agriculture, for instance the use of mulching and cover crops (????).

Adaptation needs	Measure	Mechanism to overcome the impacts of climate change
I. Improve resiliency and adaptive capacity	<ol> <li>Implement regional adaptation plans</li> <li>Improved monitoring and early warning</li> <li>Improve coordination planning</li> <li>Innovation and technology</li> </ol>	Enhances effectiveness of adaptation measures Mitigates comsequences of adverse events Enhances effectiveness of adaptation measures Improves effectiveness of adaptation measures and reduces costs
II. Response to changes in water availability	<ul> <li>(5) Innovation: water use efficiency</li> <li>(6) Improve soil moisture retention capacity</li> <li>(7) Small-scale water reservoirs on farmland</li> <li>(8) Improve the reservoir capacity</li> </ul>	Increases water availability Increases water use efficiency Increases water management flexibility at the local level Increases management flexibility and water availability at regional level
	<ul> <li>(9) Water reutilisation</li> <li>(10) Improve water charging and trade</li> <li>(11) Re-negotiation of allocation agreements</li> <li>(12) Set clear water use priorities</li> <li>(13) Integrate demands in conjunctive systems</li> </ul>	Increases water availability Decreases inefficient use of water Improves water use efficiency Improves water use efficiency Increases management flexibility and water availability
III. Response to floods and droughts	<ul> <li>(14) Create/restore wetlands</li> <li>(15) Enhance flood plain management</li> <li>(16) Improve drainage systems</li> <li>(17) Farmers as 'custodians' of floodplains</li> <li>(18) Hard defences</li> <li>(19) Increase rainfall interception capacity</li> <li>(20) Introduce drought resistant crops</li> <li>(21) Insurance to floods or drought</li> </ul>	Reduces flood peaks Reduces flood vulnerability Reduces extent and duration of flooding Decreases risk of flood damages Decreases risk of flood damages Reduces flood peaks at the local level Improves agronomic water use efficiency Decreases economic losses to the farmer
IV. Response to increased irrigation requirements	<ul><li>(22) Change in crops and cropping patterns</li><li>(23) Improve practices to retain soil moisture</li><li>(24) Develop climate change resilient crops</li></ul>	Decreases economic risk to farmers Decreases the need for additional water to crops Mitigates impacts of climate change
V. Response to changes in agricultural land use	(25) Relocation of farm processing industry (26) Addition of organic material into soils (27) Introduce new irrigation areas	Maintains industrial activity Recovers soll functions Develops new agricultural land
VI. Response to deterioration of water and soil quality	<ul><li>(28) Improve nitrogen fertilisation efficiency</li><li>(29) Soil carbon management and zero tillage</li><li>(30) Protect against soil erosion</li></ul>	Reduces agricultural diffuse pollution Reduces soil erosion and improves soil water retention capacity Reduces land degradation
VII. Response to loss of biodiversity	<ul> <li>(31) Increase water allocation for ecosystems</li> <li>(32) Maintain ecological corridors</li> <li>(33) Improve crop diversification</li> </ul>	Improves ecosystem services, effective at the global level Improves biodiversity with positive global consequences Improves biodiversity

Figure 1 – Adaptation measures that offsets the potential negative impact of climate change for agricultural water management. Source: (??)

# 3.5 Injustice, Equity and Adaptation

According to ??) environmental injustice can be understood in two ways: the first would be related to the implementation of policies - or their omission - causing disproportionate risks to those most in need of financial and political resources; and the second would represent unequal access to environmental resources, expressed in both production and consumption of these resources.

Physical water scarcity and poor access to water are often mistaken for the same thing, but they are not. Access to water and water services are aspects of water security, but they do not depend solely on physical water scarcity, although this is often cited as the only reason. In most cases, what we have are consequences of mismanagement, bad political or economic policies masked as water scarcity. In this context, people who are mostly geographically, economically, institutionally and socially marginalized do not have or have poorly access to water (??).

According to ??) water scarcity is mainly caused by a combination of three principal factors: power, poverty and inequality and not only by lack of physical water availability. The same author also pointed out depletion and degradation of the resource caused by non sustainable exploitation, population growth and unequal distribution or access to water was driven forces of scarcity, besides recognizes the role of institutions and politicians in this process. ??) studied water access equity in India and concluded that the current social and institutional arrangement was creating inequities in the access to water for sheer survival in several locations and for specific social groups. The same author also found several factors that contributes for the enlargement of the inequities, some of they are: the enlargement of water scarcity, the use of the water for economic activities (such agriculture), the exploitation of water by large industries, and the action of of economic actors within industrial sector.

??) suggest that access to water is justiciable for at least three reasons:

- If water access was seen, as income and wealth, as a prerequisite for business and livelihood opportunities
- Water plays a key role in domestic work. Without easy access to water, the tasks of maintaining a home and bringing up children are constrained.
- The time spend in water collection deprives a part of the population of opportunities to live other aspects of life. Water equity cannot be judged only by the material circumstances of access, such as quantity of potable water available. Equity must be understood more holistically. It is the capabilities enabled by water access that really matter.

The impacts of climate change are contributing to exacerbate the problems of scarcity and equitable access to water, but when we talk about scarcity, equitable access and climate change impacts, little synergy is seen between this three different issues, then a more holistic view is needed wherefore appropriate adaptation strategies are adopted and resilience is built (??). International conventions are increasingly recognizing the need to engage resource stakeholders in agendas in order to achieve their desired aims, as part of more holistic approaches to sustainable development (??).

The issue of equity and justice, in the context of climate change, is discussed more on an international scale than on smaller scales, that often receive insufficient attention. This is worrying, as it is at these smaller scales that the process of adaptation potentially widens inequalities by creating winners and losers (??).

Climate change adaptation process, in some cases, may present significant dilemmas about justice, as the impacts of climate change contribute to the worsening of the already existing cases of injustice. These problems become even more prominent in highly resource-dependent communities, scenarios that are quite common in under developed countries (?????). In general, poorer communities will be most severely affected by the impacts of climate change, but not necessarily because of the impacts themselves, but because these communities are less resilient (????).

??) studied the implications of different spatial scales for the adaptation process, and developed a set of normative evaluative criteria for judging the success of adaptations at this different scales. They argued that, among other factors, the equity is a important element for judging success in terms of the sustainability of development pathways into an uncertain future.

# 3.6 Methods for Sustainability Assessment

In the last few decades, there have been extensive efforts on measuring sustainability. One example is the development of assessment tools based on sustainability indicators, known as sustainability indices. These sustainability indices have a common purpose: to measure the sustainability (??). Well-developed indicators ought to condense and unscramble significant information by measuring, quantifying/qualifying, and transmitting data in a way that is simple to understand (??). However, in their definition process, it should not only consider the technological issue, it should also take into consideration the environmental, social, institutional, and economic aspects related to sustainability (??).

Some authors have developed general sustainability indices, such as the Environmental Sustainability Index (??), Corporate Sustainability Indicators (??), the Barometer of Sustainability (??), Environmental Pressure Indices (??), Taking Sustainability Seriously (??), Sustainability Indicator Systems (??). Some sustainability indices are field-specific, such as indicators for environment (??), agriculture (??), fossil fuel (??). Indices for water resource sustainability, for example, are the Water Poverty Index WPI (??), Canadian Water Sustainability Index CWSI (??), Watershed Sustainability Index WSI (??) and West Java Water Sustainability Index WJWSI (??). The main goal of all these indices is to measure sustainability, which can be used after that to help decision makers and other stakeholders accomplishing sustainable development. Additionally, the indices can also be used to communicate the progress of sustainability to wider community (??).

One important aspect of sustainability assessment is to set targets and then measure the distance between the target and the current state or trend (??). In terms of interpretation, if the indicator was applied over a long period of time, it can be used to determine a trend. In this case, we use reference points to measure the proportion of the change. The simplest reference point is the baseline. Baselines are starting points for measuring change from a certain state or date (??). We can also utilize absolute values, although them, by their own, may not entirely matter, since we need a notion of what is admissible. So the called reference values has the purpose of giving a meaning to absolutes values, establishing what is admissible, and differentiating them from raw data (??).

The scientific community emphatically suggests the adoption of indicators for the assessment and monitoring of advances towards sustainable development. Besides it, international organizations consider that indicators are effective decision-making instruments. The pertinence of indicators for the decision-making process is one of the most vital features of the indicators in relation to other forms of information. In any case, the quality and reliability of the indicators depends on the application of satisfactory and fitting criteria to evaluate them (????).

The selection of a appropriate indicator is extremely important. ??) suggested observing the aspects listed below during the selection of an indicator.

- Sensitive to change in time: An indicator should be usable along a time series of data, so it can be possible to see how the indicator have changed over time.
- Sensitive to change across space or within groups: An indicator must represent the changes occurred across space or within groups.
- **Predictive or anticipatory:** An indicator should be capable of predict or anticipate the signs of unsustainable conditions, and once the signal is received, the indicators can be used to identify the main causes for the unsustainable signal.
- **Reference or threshold values available:** Indicators will be more useful if reference or threshold values to assess them are available.

- Unbiased: Biases in the selection of sustainability indicators may occur due to various reasons, such as the existing knowledge of the index developer, political interests, and the background given in the existing literature.
- Appropriate data transformation: For most indicators, the identified indicator is not the raw data. Therefore, to obtain the value for the indicator, appropriate data transformations or calculations are needed. It is important to carefully develop or adopt the appropriate method for transforming the data into the meaningful indicator value.
- **Integrative:** The main causes that lead to the not sustainable conditions must be known so the process could be understood as a whole.

The increasing of sustainable development concepts and environmental concerns has been leading to a broad and strongly application of indicators by a large number of users in different contexts, including water resources (?????). The United Nations World Water Assessment Programme (??) comments that "a staggeringly extensive array of indicators have been developed, or are proposed, to monitor the state, use and management of water resources, for a wide range of purposes." These indicators can give information on current conditions of water resources, including recognizing all components contributing to the enhancement of water resources management. This data can be utilized to communicate the current status of existing water resources to the wider community and are powerful decision making tools and key components to monitor advances towards sustainable development within the water sector (??).

??) identified 170 indicators related to water use and management and evaluate how each one of them perform against a set of sustainability criteria. They found that only 24 indicators fulfill the majority of the sustainability criterias. Among the 24 sustainable indicators, is the Water Footprint (??). ??) points that water footprint is an indicator that allows a comprehensive view of the sustainability of water use and can be assessed within the framework of IWRM. In the next section, the Water Footprint indicator will be explained in a more detailed way.

# 3.7 Water Footprint

The concept of water footprint was first introduced by ??) who, inspired by the concept of the ecological footprint by ??), developed an indicator to investigate water consumption and pollution along supply chains. Today water footprint has taken on a far greater role than that, becoming a powerful tool for assessing the sustainability of water use, exploring the possibility of water use reduction and encouraging the replacement of inefficient and polluting methods with more efficient and cleaner ones (??).

Basically, the water footprint expresses the human appropriation of water in terms of volume. Comparing this water footprint with the water availability of the study area, it is possible to evaluate the sustainability of this appropriation, so that is possible, thus, to improve the decision-making process in water resources (??).

??) presents the three pillars of smart water allocation:

- Water footprint benchmarks per basin: Establish maximum volumes of water that can be consumed or polluted by human activities per basin. Aims to ensure water sustainability within each basin.
- **Reference water footprints for products:** Aims to encourage producers to reduce the water footprint of their products to a reasonable reference level.
- Fair sharing of water footprint between communities: It aims to contribute to the debate on social equity. Water allocation must be ecologically sustainable and resource efficient, but only this does not guarantee that it is socially fair. There is a need to be an international consensus on what makes the water footprint of a community fair or acceptable given the maximum value of sustainable water footprint per global citizen.

Using the water footprint indicator provides valuable information to facilitate the water allocation process, both economically and environmentally, as it provides new data to address water scarcity and pollution issues (??).

Water footprint has already been proven useful in assessing risks related to water scarcity and pollution. It can be used together with economic instruments to gauge the implications of a water scarcity scenario on the economic development of a certain region. Thus, the water footprint should be used by decision makers to communicate with a wider audience, beyond the scientific community (??).

There are three types of water footprint: green, blue and gray. The green water footprint refers to the use by humans of water that evaporates from the soil surface (mainly due to the growth of crops and forests used for logging). The blue footprint refers to the consumptive use of superficial runoff water, in other words, it is the volume collected from some water source (surface or groundwater reservoir) that does not return to its original source. The gray footprint refers to the appropriation of the ability to assimilate pollutants from a given water source, ie, it measures the volume of water needed to dilute a particular polluting load dumped in a water body (??).

How the water footprint will be expressed will depend on the focus of the work. It is possible to calculate the water footprint of a specific process within a production chain, product, consumer, consumer group, producer, an entire economic sector, geographical area (rural property, watershed, municipality, state, country, or even the entire planet) (?????????).

The water footprint can be estimated by various methods, each with different degrees of accuracy and specific limitations. ??) present a series of equations for calculating the footprint of various services, products, groups of people, etc. ??) developed a way of estimating agriculture's water footprint using only remote sensing data. ??) used the CROPWAT model as an auxiliary tool to calculate the water footprint of various crops.

In the subsection below will be presented the calculation methodology proposed by ??) for estimating agriculture's water footprint (regardless of the type of crop).

#### Green Water Footprint Calculation

Green water footprint is calculated as the ratio of the volume of "green water" used for crop production  $CWU_q(m^3/m^2)$  to its yield  $Y(ton/m^2)$  (Equation ??).

$$WF_{green} = \frac{CWU_g}{Y} \tag{3.1}$$

"Total green water" is calculated as the sum of the "green water" used in each month  $u_g(mm/month)$  over the entire growing season. Assuming that the water demand of the crop is fully met, the monthly green water use will be the smallest value between the effective rainfall  $(P_{eff})$  and crop evapotranspiration  $(ET_c)$  (Equation ??).

$$u_q = min(P_{eff}, ET_c) \tag{3.2}$$

There are several methods available for estimating evapotranspiration. ??) calculated the water footprint using different evapotranspiration estimation methods to determine the difference in the WF values obtained by the different methods. His conclusion was that the method chosen for estimating evapotranspiration (and then using it to estimate water footprint) does not significantly alter decisions at the policy level related to water resource management, thus it is possible to use any of the estimation methods without prejudice to the final decision.

#### Blue Water Footprint Calculation

The blue water footprint  $(m^3/ton)$  is calculated by Equation ??, in a similar way to the green water footprint.

$$WF_{blue} = \frac{CWU_b}{Y} \tag{3.3}$$

Blue water  $u_b$  is defined as the water used for irrigating the plantation. On a monthly scale, assuming that the irrigation water demand will be fully met, blue water will be equal to the highest value between zero and the difference between crop evapotranspiration and effective rainfall (Equation ??).

$$u_b = max(0, ET_c - P_{eff}) \tag{3.4}$$

#### Gray Water Footprint Calculation

The gray water footprint  $(m^3/ton)$  of a crop (Equation ??) depends on the amount of fertilizer applied on it per square meter  $(kg/m^2)$ , where *alpha* is the fraction of fertilizer carried by the runoff.  $c_{max}(mgl^{-1})$  is the maximum acceptable concentration,  $c_{nat}(mgl^{-1})$ is the natural concentration of the pollutant in the receiving body of water, and Y is the crop yield.

$$WF_{grey} = \frac{\alpha.AR.Y}{c_{max} - c_{nat}} \tag{3.5}$$

## Total Water Footprint Calculation

The total water footprint is calculated by the sum of the three types of water footprint (green, blue and gray) (Equation ??).

$$WF = WF_{green} + WF_{blue} + WF_{grey} \tag{3.6}$$

# 3.8 Uncertainties and the Decision Making Process

According to ??) the rational decision making process is one that can achieve the pre-set objectives effectively and efficiently. ??) divides the rational decision making process into 6 steps, they are:

- 1. Problem Definition
- 2. Criteria Identification
- 3. Weighting of criterias
- 4. Generation of alternatives
- 5. Classification of alternatives according to the criteria
- 6. Optimal solution identification

However, the decision maker can exchange the best solution for one deemed acceptable or reasonable based on his own rationality or interest (??).

It is essential that the social dimension is also included in the decision-making process. ??) observed that, in developed countries, the quality of decision-making increased when social impact assessment began to be done, which can be understood as the process of identifying future consequences for individuals, organizations or macro-social systems of actions that can be taken in the present.

One of the major difficulties of the decision making process in water resources is the uncertainties associated with the behavior of the systems under study, especially those associated with the random behavior of hydrological events. ??) classify the uncertainties inherent in mathematical modeling of hydrological systems into three types:

**Type I uncertainties:** These are those caused by ignorance and/or difficulties in natural process representation. So far, they are impossible to avoid, since every model is just a simplification of what happens in reality. The greater the sophistication of the model, the lower is this type of uncertainty.

**Type II uncertainties:** They occur due to the determination of model parameters from inadequate field samples. They can be decreased by increasing the amount of information collected.

**Type III uncertainties:** They are inherent in natural processes. Since it is impossible to reduce them, the only thing you can do is to know them and incorporate them into the planning.

??) points out several factors that generate uncertainties in the management of water resources, they are: randomness of hydrological events, adoption of inaccurate models, simplifying hypotheses, relativity of the principles adopted and connection with environmental and socioeconomic components which present great variability.

Another type of decision-making uncertainty that has not been mentioned above is future-related uncertainty (or randomness), it happens because decision-making process occur to meet a multiple number of objectives and that complex negotiations will be necessary for the decision-making process to take place (??).

According to ??), there are two types of approaches to dealing with future randomness related to hydrological uncertainties:

1. Explicitly stochastic approaches: use probabilistic models to simulate future-

related randomness. Decision making is solved by optimization

2. Implicitly Stochastic Approaches: Its use is more common than the previous approach. It is assumed that future hydrological events are known before the decision-making process.

??) points out four steps that can be taken when facing a uncertainty scenario:

- 1. Ignoring uncertainties, which is not a prudent attitude, because it generates many associated risks
- 2. Avoid uncertainties through mitigating measures. This reduces the negative impacts caused by them, although it does not eliminate the problem source.
- 3. Reduce uncertainties by deepening research and collecting more data and information.

Knowing the uncertainties embedded in the models is very important, as uncertainties generate risks that hinder the rational decision making process. According to ??), the 4 steps for risk management analysis are:

- 1. Risk identification
- 2. Risk Qualification
- 3. Risk Minimization
- 4. Mitigation or remediation of risk effects

There are three criteria for uncertainty decision making (????):

- 1. MaxMin Criterion: It is supposed that the worst case scenario will happen
- 2. MaxMax Criterion: It is supposed that the best case scenario will happen
- 3. Hurwicz Criterion: It's a middle ground between the previous ones, in it the least regrets are calculated

The most used criterion in the area of water resources has been MaxMin, where decisions are made taking into consideration that the worst scenario (extreme drought) will happen (??).

# 3.9 Multi-objective Optimization Models

Multi-objective optimization has a huge practical importance, since nearly all real-world optimization problems and most practical decision-making problems are ideally suited to be modeled utilizing multiple conflicting objectives. However, in the past, due to lack of suitable solution methodologies, these problems were solved by transforming the multiples objectives into a single objective. In a single-objective optimization problem, the task is to find one solution and, extending that idea to multi-objective optimization, it may be wrongly assumed that the task in a multi-objective optimization is also to find an optimal solution. This type of approach was not satisfactory, because multi-objective optimization problems often have not only one solution, but several (known as Paretooptimal solutions, if we have conflicting objectives), so it is important to find as many optimal solutions as possible and not just one single solution (??).

Another difference between single-objective and multi-objective optimization is that in the latter there is an additional multi-dimensional space in addition to the search space common to all optimization problems. This additional space is called objective space; For each point in the search space, there is a corresponding point in the objective space (??). Figure ?? shows the representation of the decision variable space and the corresponding objective space.

Several multi-objective optimization algorithms make use of the dominance concept. In these algorithms, two solutions are compared based on whether one dominates the other or not. According to ??) we can say that a solution  $x_1$  dominates another solution  $x_2$  if the following conditions are true

- 1. The solution  $x_1$  is no worse than  $x_2$  in all objectives.
- 2. The solution  $x_1$  is strictly better than  $x_2$  in at least one objective.

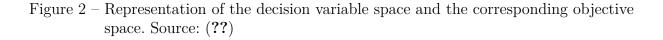
As mentioned earlier there is usually not only a single solution to multi-objective optimization problems, but a set of solutions. According to ??) the concept most commonly used to define this optimal solution set is the Pareto Optimality (??) which is defined by:

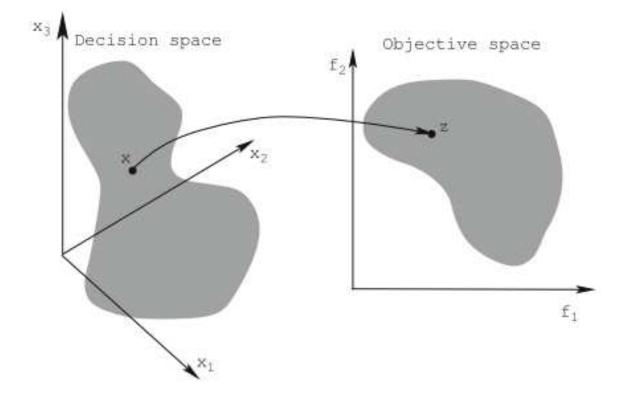
**Pareto Optimal Definition:** A point,  $x^* \in X$ , is Pareto optimal if there does not exist another point,  $x \in X$  such that  $F(x) \leq F(x^*)$ , and  $F_i(x) \leq F_i(x^*)$  for at least one function.

Where:

x: is a vector of decision variables

X: is the search space (often called the feasible decision space)





F(x): is a vector of objective functions  $F(x) = [F_1(x), F_2(x), ..., F_i(x)]$  which we want to minimize.

 $F_i(x)$ : is a objective function, also called criteria, payoff functions, cost functions, or value functions.

There are several methods used to solve multi-objetive optimization problems. Among them we can cite:

- Weighted-Sum Approach: The weighted-sum method, as the name suggests, join a set of objectives into a single objective by pre-multiplying each objective with a weight (??).
- $\varepsilon$ -Constraint Method: Used for solving problems that have non-convex objective spaces, which weighted-sum approach faces difficulties (??).
- Simulated Annealing: This approach is used usually to solve large scale combinatorial optimization problems (??).
- Quantum Annealing: Similar to the Simulated Annealing, Quantum Annealing uses quantum algorithm and Quantum Adiabatic Computers to solve multi-objective combinatorial optimization (??).

• Evolutionary Multi-objective Optimization (EMO) Method: The algorithms that have propose to to deal with multi-objective optimization using evolutionary computation. There are several algorithms within this group, for instance: Strength Pareto Evolutionary algorithm (SPEA), Non-dominated Sorting Genetic Algorithm (NSGA), Vector-Evaluated Genetic Algorithm (VEGA), Pareto Archived Evolution Strategy (PAES), Particle Swarm Optimization, Artificial Immune Systems Algorithm, Estimation Distribution Algorithm, etc (????).

In this work, we choose to utilize SPEA2, a kind of genetic algorithm that belongs to the group of the evolutionary algorithms (EAs). During the last two decades, it was possible to see a dramatic increase in the development and application of various types of evolutionary algorithms, especially the genetic algorithms, undoubtedly the most popular of the several types of EAs. EAs have proven to be flexible and powerful tools for solving complex water resources problems and have been applied and different researches have been done in the water resource optimization (?????), including the optimization of the water use for agricultural irrigation (??). According to ??), evolutionary computation will continue to evolve in the future as problems become more complex, uncertainties increases and social pressure for more innovative and efficient solutions increases.

# 4 Methodology

# 4.1 Strenght Pareto Evolutionary Algorithm 2 (SPEA2)

The Strength Pareto Evolutionary Algorithm (SPEA) is an algorithm for multiobjective optimization and an evolutionary algorithm of the field of evolutionary computing. It belongs to the field of evolutionary multi-object algorithms (EMO). SPEA is an extension of genetic algorithms used to solve multiobjective optimization problems. Other evolutionary algorithms similar to it are: Non-dominated Sorting Genetic Algorithm (NSGA), Vector-Evaluated Genetic Algorithm (VEGA), and Pareto Archived Evolution Strategy (PAES). There are two versions of SPEA, the original SPEA and its successor, SPEA2. It can be also mention two extensions, SPEA + and iSPEA (??).

The purpose of this algorithm is to locate and maintain a boundary of nondominated solutions, also known as the Pareto Frontier. To do this it uses an evolutionary process (which includes procedures for genetic recombination and mutation) and a process that uses a combination of the concept of solution dominance with the neighborhood density concept (??).

Before detailing the operation of SPEA2, it is important to give a general explanation of the genetic algorithm, predecessor of SPEA. Genetic algorithms were first introduced by John Holland (??) and popularized by one of his students, David Goldberg (??).

These algorithms are inspired by the principle of natural selection and survival of the fittest, first introduced to the world in 1859 by English naturalist and physiologist Charles Darwin in his book "The Origin of Species." In his work, Darwin argues that, within a population, the fittest individuals are more likely to survive and, consequently, leave more offspring that will carry their genes and take them to future generations. Coupled with this process of natural selection are the phenomena of genetic recombination (also called "crossover") and mutation, which occur during the reproduction process and are vital to ensuring diversity among individuals and allowing fitters individuals to emerge in future generations.

According to ??), there are basic procedures that are common to the implementation of any genetic algorithm, these are:

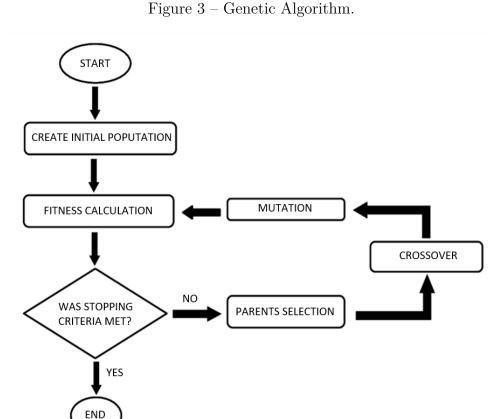
- 1. Choice of decision variables representation system
- 2. Generation of an initial population, containing various solutions to the problem.

3. Definition of one or more objective functions

50

- 4. Specification of genetic operators for selection, recombination and mutation mechanisms
- 5. Determination of various vestments (initial population size, probability of recombination and mutation, termination condition, etc.)

The first version of the genetic algorithm, proposed by ??), works in a relatively simple way to understand. First, possible solutions were represented in the form of "chromosomes", which are nothing less than strings of bits. The initial population consists of several randomly generated chromosomes from the search space (region where all solutions to the problem are contained). The next step is to evaluate the suitability of each solution using the objective function and then sort the solutions from the most fit to the least fit. The best chromosomes in the population are then transferred to an intermediate population, while the rest are discarded. A new generation of individuals is then produced by recombining the chromosomes of the intermediate population. A small percentage of the child chromosomes is modified by the mutation operator. This whole process is repeated, producing populations with increasingly fit individuals to the point where some termination criteria is met. This process is shown in Figure ??.

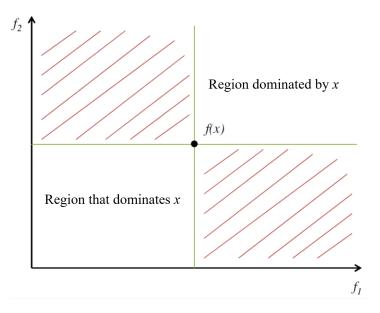


SPEA2 works similarly to Holland's original version, although it has some differences from it. Like Holland's algorithm, SPEA2 starts by generating an initial population composed of random individuals produced from the search space. After that, each individual's fitness is calculated (each individual has a fitness value for each objective function). These fitness values are subsequently used to analyze dominance relationships between individuals.

Consider a multiobjective optimization problem with r objectives, where we simultaneously want to minimize the r objective functions  $f(x) = f_1(x), ..., f_r(x)$ . One solution x is said to dominate another solution y if and only if  $f_i(x) \leq f_i(y)$  to i = 1, ..., r and  $f_i(x) < f_i(y)$  for at least one objective function i.

Figure ?? presents, for a problem with two objectives, the region dominated by solution x, the region that dominates this solution, and the regions that neither dominate nor are dominated by it.

Figure 4 – Representation of the dominance concept in the objective's space.



A Strength value is calculated for each individual in the initial population, which is equal to the number of individuals dominated by the individual under analysis. Then, the Raw Fitness value is calculated, which is the sum of the Strengths of the individuals who dominate the individual under analysis. The more solutions dominated by an individual, the greater the value of their Strength, while the fewer individuals dominate the solution under analysis the lower their value of Raw Fitness. Therefore, if a solution is not dominated, the value of its Raw Fitness will be zero. When individuals are indifferent to each other (neither dominate nor are dominated by each other), no conclusion can be drawn from the concepts of dominance.

Since all non-dominated individuals will have the same value of Raw Fitness (zero),

some additional information is needed to differentiate them. In this case, the concept of neighborhood density is used to determine, among these individuals, which are the most fit. Neighborhood density is a decreasing function of the distance of the k nearest neighbor of the individual under analysis. In this study we considered k = 1. Equation ?? shows the formula for calculating neighborhood density.

$$D = \frac{1}{\sigma^k + 2} \tag{4.1}$$

Where:

D: Neighborhood Density

 $\sigma^k$ : Euclidean distance between individuals or, for k = 1, is Euclidean distance to nearest neighbor.

The neighborhood density value ranges from 0 to 0.5, where the highest value represents the case where the two individuals are equal (the Euclidean distance between them is zero). The lower the neighborhood density, the more isolated the solution is in relation to others, so it is more important to preserve it in order to maintain diversity among solutions (critical to helping the optimization method converge to the global optimum).

An individual's fitness will then be given by the sum of his Raw Fitness value and neighborhood density, as shown in Equation ??. Then, the lower the value of fitness, the more fit the individual is, and the more likely they are to pass on their characteristics to the next generation.

$$F = RF + D \tag{4.2}$$

All non-dominated individuals in the population are transferred to the external population (population smaller than the initial population, which contains the best individuals and where the parents of the next generation will come from). If the external population is not fully populated, it is completed with dominated individuals, ranked in ascending order of Fitness value. If the number of non-dominated individuals exceeds the size of the external population, surplus solutions will be excluded in decreasing order of neighborhood density.

If the termination criterion is not met, individuals from the external population will be sent to genetic operators, where they will generate individuals for the new population, restarting the process, which will continue until a certain number of generations are reached or until termination criteria are met.

# 4.2 Optimization Algorithm

In order to obtain an algorithm that was capable of producing strategies for adapting to climate changes along the lines presented in this work, some adaptations were made to the original SPEA2 code. A code produced by ??) (that is a adaptation of SPEA2 as well) was used as a basis for the development of the present source code. Figure ?? presents the general structure of the optimization algorithm, that will be detailed step by step into the following subsections. The code is presented integrally on Appendix ??.

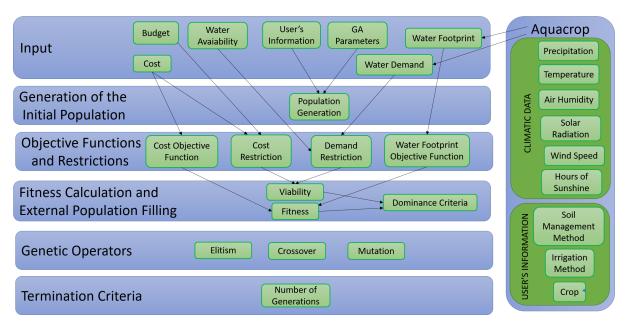


Figure 5 – General representation of the optimization algorithm.

## 4.2.1 Input

In order to the algorithm to work properly, a series of information should be provided either directly to the genetic algorithm (GA) or indirectly through Aquacrop. The data provided directly to the GA are the following:

- Budget: The maximum value that should be expend on adaptation strategies.
- Cost information: The cost to make changes (in  $\mathbb{R}^{3}/m^{2}$ ) for each measure that could be taken.
- Water availability: The water availability (l/s) for all users considered into the adaptation process.
- Users information: Such as crop, irrigation method, and soil management method, provided according with the mathematical representation presented in the next topic.
- **GA parameters:** Number of individual in the initial and external population, probability of occurrence of crossover and mutations, and termination criteria.

- Water demand: It will be estimated by Aquacrop.
- Water footprint : It will be estimated by Aquacrop.

#### 4.2.2 Mathematical Representation of the Problem

We choose to represent the problem mathematically through a two-dimensional matrix, where each column represents a user  $(u_n)$  and each row provides information about it. The first line contains information about the type of crop planted by that user  $(C_n)$ , the second is the irrigation method used by him  $(MI_n)$  and the third is the soil management method practiced by him  $(MI_n)$ . Figure ?? shows an example of a generic solution.

Figure 6 – Generic mathematical representation of a solution.

$ \begin{matrix} u_1 \\ C_{u1} \\ IM_{u1} \\ SM_{u1} \end{matrix} $	$u_2 \\ C_{u2} \\ IM_{u2} \\ SM_{u2}$	  	$egin{array}{c} u_n \ C_{un} \ IM_{un} \ SM_{un} \end{array} \end{bmatrix}$		
u - FARMERS $C - CROP (1 \le C \le c)$ $IM - IRRIGATION METHOD (1 \le IM \le im)$ $SM - SOIL MANEGEMENT (1 \le SM \le sm)$					

In order for the optimization algorithm to work properly, all information in the mathematical matrix must be numeric, so data on crop type, irrigation method and soil management had to be represented by numbers as explained below:

**Crop Type:** Crops suitable for cultivation in the study area were divided into c groups according to their water footprints. The value of the first row of the solution matrix ranges from 1 to c and indicates which crop group the user irrigates in their property. Where 1 represents the group that contains the crops with the largest water footprint and c is the group that has the lowest water footprint.

**Irrigation Method:** We considered the irrigation methods that are already used by the farmers and the most efficient ones. The total number of methods available for use (im) were identified by values ranging from 1 to (im), where, as for crops, they were organized according to their efficiency (here we consider the most efficient method as the one that wastes less water). The most inefficient method was identified by number 1, while the most efficient by the number im.

Soil management: The *sm* soil management strategies that could be implemented in the study area were identified and, as well as the previous characteristics, organized according to their effectiveness in saving water and consequently reducing the water footprint. The value 1 was attributed to the no adoption of soil management methods, while the sm value was attributed to the most efficient soil management method.

#### 4.2.3 Generation of the Initial Population

Before generating the initial population individuals, the study area current configuration was represented through the matrix presented in the previous section (same representation that will be adopted for the solutions). After that, initial population individuals were generated from the following rule: In each cell of the matrix, a random integer number will be stored. The value of that random integer number shall vary between the value stored in that same cell in the matrix that represents the current study area configuration and the maximum value that cell can get (c, im, or sm, for rows 1, 2, and 3 respectively).

Thus, the solutions generated will always be better (more efficient) or equal than the current configuration of the study area, therefore not allowing setbacks to be made. Limiting the maximum value of cells also prevents the suggestion of solutions that do not correspond to any methods (for instance, preventing a solution from suggesting that user x changes its irrigation method to method number 7, as there are only 6 methods available (ie method 7 does not exist)).

#### 4.2.4 Aquacrop OS and the Water Footprint Calculation

Before initiating the optimization algorithm, the code uses Aquacrop OS software to calculate crop's water footprint. In the subsection below we will explain, in a general way, how Aquacrop works, how it differs from Aquacrop OS and how the genetic algorithm exchange information with this model.

#### 4.2.5 Aquacrop

AquaCrop is a model for crop growth simulation, created by FAO to ensure food security and proper management of agriculture. It simulates the agricultural productivity of a given crop if a certain amount of water is supplied to it during its growing season. AquaCrop is particularly useful in cases where water is the limiting factor for crop yield.

There are a large number of crop growth simulation models available in the literature. Examples: DSSAT (??); CropSyst (??); Hybrid-Maize (??). However, a problem common to the vast majority of these models is the demand for a high amount of input data with high level of details, which is not available for the most part of the planet.

Aquacrop stands out from other models that serve for the same purpose as it because it requires a relatively smaller number of parameters to be set by the user, and has been validated and applied to various crop types in multiple climate types and in different locations (??).

??) compared the performance of AquaCrop with CROPWAT (older version of AquaCrop) for estimating the water footprint of cotton in a region of northern Greece. The results showed superiority of AquaCrop in relation to the other model in this regard.

Currently, AquaCrop is one of the main tools used to calculate the water footprint of irrigated agriculture. It is possible to cite several works where this model was used for this purpose, among them we have: ??), ??) and ??).

AquaCrop is available in three versions: A standalone Windows application, a GIS plugin and an open-source version for Matlab. In this work, we will use the Matlab version.

The following description of how AquaCrop works was based on its reference manual, available at ??).

Similar to other crop growth models, AquaCrop is composed of a set of sub-models that simulates: the soil (and its water balance), the crops (its growth, development and yield), the atmosphere (its temperature, precipitation, evaporation, and concentration of carbon dioxide), and soil and crop management practices (irrigation and soil fertilization, for instance).

AquaCrop simulations are done on a daily time scale and can be represented by calendar days or growing degree days. AquaCrop simulates the soil water balance by accounting for the inlet and outlet water flows of a control volume, as shown by Equation ??.

$$S_{[t]} = S_{[t+1]} + PR_{[t]} + IRR_{[t]} + CR_{[t]} - ET_{[t]} - RO_{[t]} - DP_{[t]}$$
(4.3)

Onde:

 $S_{[t]}(mm)$  - Water stored in the soil at the end of the day t<br/> $S_{[t+1]}(mm)$  - Water stored in the soil at the beginning of the day t<br/> $PR_{[t]}(mm)$  - Daily rainfall t<br/> $IRR_{[t]}(mm)$  - Irrigation water applied in a day t<br/> $CR_{[t]}(mm)$  - Deep aquifer capillary rise in a day t<br/> $ET_{[t]}(mm)$  - Daily actual evapotranspiration t<br/> $RO_{[t]}(mm)$  - Daily surface runoff t<br/> $DP_{[t]}(mm)$  - Percolation to deep aquifer in a day t

To calculate effective precipitation, surface runoff and soil water infiltration, AquaCrop uses the Soil Conservation Service (SCS) method. Actual evapotranspiration is separated into two parts: one non-productive (evaporation of water from the soil surface) and one productive (transpiration from plants). Thus, it is possible to simulate the effect of management practices on these two plots separately. This program feature is fundamental for estimating the water footprint.

Evaporation from soil surface is calculated by multiplying potential evapotranspiration by factors that take into account soil water availability and the fraction of the soil surface that is covered by the leaves (canopy cover). The calculation of water evaporation over the uncovered soil surface is done in two steps. In the first step, which occurs whenever the soil is wet due to rain or irrigation, the evaporation rate is determined solely by the energy available to evaporate water. In the second, evaporation ceases to depend only on available energy, and now also depends on the hydraulic properties of the soil.

To estimate the biomass production (B) of a given crop, AquaCrop take into account two parameters: water productivity (WP) and crop transpiration (Tr) (Equation ??). Water productivity is a parameter that expresses biomass production (kg) per  $m^2$  of area, per mm of transpirated water, adjusted according to the evaporative demand of the atmosphere and the concentration of  $CO_2$  in the air.

$$B = WP \times \sum Tr \tag{4.4}$$

It is possible to simulate various options of water supply, ranging from rainfed agriculture to fully irrigation. It is also possible to choose between different types of irrigation methods (surface, sprinkler or drip) and soil management practices (soil fertilization, plastic or organic mulch, barriers to reduce runoff, and plant control). The impact of water stress on plant growth is modeled with three types of response: change in leaf growth rate, stomatal closure and senescence acceleration.

Biomass production can be reduced by the action of some external agents, they are:

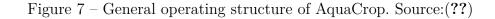
- Temperature: Extreme temperatures (too high or too low) affects crop growth
- Soil Salinity: High salinity soils have a negative influence on plant growth
- Water stress: Lack of water, especially at some stages of plant growth, can cause a significant decrease in productivity
- Soil fertility: Poorly fertile soils are limiting factors in crop growth

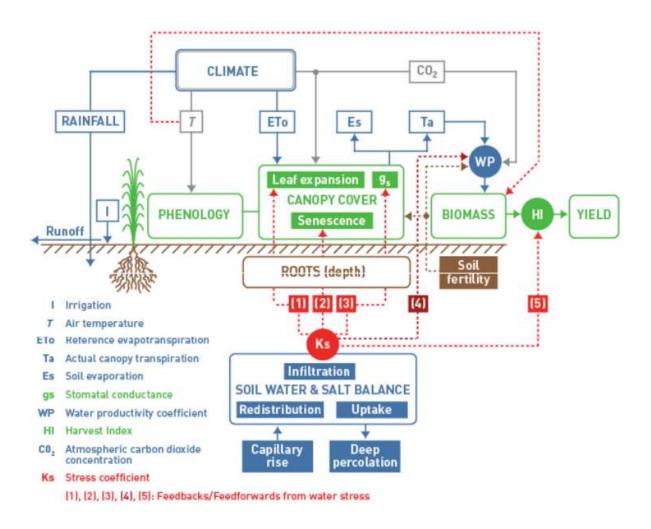
After estimating biomass, it is multiplied by the HI factor to obtain crop's yield Y. HI (harvest index) is the harvest factor and represents the percentage of biomass that actually becomes harvest. HI varies from culture to culture and is adjusted according to water and temperature stress, depending on how long the crop is exposed to stress

and how intense it is. For this, the harvest index reference value  $HI_0$  is multiplied by an adjustment factor  $f_{HI}$ , as shown by Equation ??.

$$HI = f_{HI} \times HI_0 \tag{4.5}$$

The overall structure of AquaCrop, including its main components, as well as the relationship between them, can be seen in Figure ??.





## 4.2.6 AquaCrop-OS

AquaCrop OpenSource (or AquaCrop OS) is an open-source version of AquaCrop, implemented in Matlab and also compatible with the free GNU Octave language. Unlike its original version, which was developed in Delphi and distributed only for Windows, AquaCrop OS can run on Windows, Macintosh and Lixus operating systems. An additional feature of AquaCrop OS is the ability to perform multiple simulations simultaneously (Batch run), significantly reducing the total processing time for large or complex projects.

Among all the features of AquaCrop OS, perhaps the one that is most relevant to this work is its ease of integration with other models. AquaCrop OS follows the OpenMI (Open Modeling Interface) standard, which is basically an interface standard designed to allow data to be exchanged between different models at runtime. This ease of connection allows AquaCrop OS to be part of integrated models for water resources management.

## 4.2.7 GA - Aquacrop OS Interaction

Both input and output data from Aquacrop OS are done via text files (extension .txt). This feature has made it much easier to integrate AquaCrop OS with the genetic algorithm, as this file extension is very simple to open, read and edit in Matlab. Input files can be divided into two categories, essential and optional. The essentials files are the ones required to make the model work, while the optional ones may or may not be necessary, depending on the type of simulation you want to perform.

Essential input files include information such as: simulation's start and end date, climate data on daily basis (precipitation, temperature, air humidity, solar radiation, wind speed, hour of sunshine on a day, etc.), soil profile data, crop data, information on irrigation methods used, information on soil management strategies used, aquifer data (if present), and initial soil water content data. Optional input files may include data about: soil texture, soil hydraulics, crop rotation calendar and irrigation calendar.

Among all input files, GA received permission to edit the following parameters in the following files:

- Crop parameters file: All parameters can be edited.
- Irrigation methods parameters file: The parameters concerning the efficiency of the method and the percentage of soil surface that is wetted can be changed.
- Soil management methods parameters file: Two parameters can be changed. The first indicates whether or not there is mulching on the soil, while the second specifies the reduction in soil water evaporation due to the presence of mulching (the plastic mulching causes a greater reduction in evaporation than the organic).

After running Aquacrop, the results produced are written in the output files. Among the miscellaneous data provided by the program, only four variables are imported and used by the GA to calculate the water footprint and water demanded for irrigation, they are:

- Water evaporation from soil surface (Es) [mm]
- Crop transpiration (Tr) [mm]
- Crop Yield (*Yield*) [ton/ha]
- Water used for irrigation (TotIrr)  $[mm/m^2]$ : This data is used to calculate the farmer's water demand for irrigation

#### 4.2.8 Water Footprint Calculation

Based on the data provided by Aquacrop, it is possible to calculate the water footprint (WF) in liters per kilogram (l/kg) using the Equation ??. In this work only the blue and green portions of the water footprint were considered.

$$WF = 10 * \frac{Es + Tr}{Yield} \tag{4.6}$$

Before starting the interactive process, GA calculates the water footprint for all combinations of crop type, irrigation method and soil management. As this work considers six types of crops, six types of irrigation methods and three soil management possibilities (totaling 108 possible combinations, ie 108 WF calculations), it was realized that it was much faster (in processing time) to calculate the footprint of all possible scenarios than individually calculate the footprint of all users of all individuals of all generations (considering 1000 generations, 500 individuals per population and 27 users, there are 13.5 million WF calculations).

In this work, to estimate the water footprint of each farmer, a simulation of one year long as performed. The sowing data was always put in the begging of the dry period (were the demand for water for irrigation is bigger). So, the water footprint was estimated based on the amount of water needed to supply a specific crop along a year, divided by the annual yield of that same crop.

## 4.2.9 Optimization Objectives and Constrains

We define two objective functions for the adaptation process: one to minimize the system's WF, and another to minimize adaptation's financial cost. A set of Pareto solutions considering the two main objectives of the adaptation process, since these two main objectives are opposed (the more the efficiency increases, the more it costs) was also generated. The intention is to present this set of Pareto solutions to the users as a list of options from where they can choose one solution, in a participatory process, and implement it on the ground.

Objective # 1 Minimization of the water footprint

This objective function aims the maximization of the water use efficiency through the minimization of the sum of all users water footprint, as shown in Equation ??.

$$f_1 = \sum_{i=1}^{u_n} WF_i$$
 (4.7)

Where:

 $f_1$ : First objective function fitness value

 $u_n$ : : Number of users

 $WF_i$  Water footprint of user i (l/kg)

The formulation of this function has the purpose of inducing the optimization algorithm to prioritize smallholder users. This is possible because a reduction of the WF of a smallholder user has the same impact in the fitness value of the same reduction to a larger user. Reducing the WF of a large user costs more than reducing the WF of a small user, then it is more advantageous (for the optimization algorithm) to adapt the smaller user first.

**Objective # 2** Minimization of the adaptation monetary cost

This objective function aims to minimize the monetary cost to implement the adaptation strategies. It is calculated based on what changes from one time step to the next and the cost to do so. Equation **??** shows the second objective function.

$$f_2 = \sum_{i=1}^{u_n} (c(MI_i) + c(MS_i)) * A_i$$
(4.8)

Where:

 $f_2$ : Second objective function fitness value

 $u_n$ : Number of users

 $c(MI_i)$ : Unitary cost  $(R\$/m^2)$  to implement user's *i* new irrigation method  $c(MS_i)$ : Unitary cost  $(R\$/m^2)$  to implement user's *i* new soil management method

 $A_i$ : User's *i* irrigated area  $(m^2)$ 

Variables  $c(MI_i)$  and  $c(MS_i)$  vary according to the different options of methods that the user could choose (each option has its specific cost). The value of these two variables is assumed to be equal to zero if there is no change in irrigation method or soil management method of the user *i* in the time step since we want to calculate the cost to change. The cost to change crop type was not taken into consideration in this work but in further research, it could be inserted through a  $c(C_i)$  v term into the equation. Besides these two objectives, two constraints were imposed to ensure that the adaptation cost does not assume too high values and that the demand does not overcome water availability. Solutions that violates at least one constraint are considered unviable.

**Restriction** # 1: If the cost to implement a solution is bigger than a previously established value (budget), that solution is considered unviable. This constraint aims to prevent the suggestion of adaptation strategies that are out of the local user's financial capability.

**Restriction** # **2**: If the total water demand (of all users) is bigger than the water availability for the time period, that solution is considered unfeasible. This constraint aims to prevent the algorithm to suggest solutions that are in controversy with the potential impacts of climate change.

In the study area, the adaptation strategies focus on more efficient irrigation methods, soil management methods and changes in irrigated area. Among the farmers considered, none currently uses improved soil management practices, so all the surveyed methods are suggestions for future adoption during the adaptation process. Among all practices, only the mulching practices were considered, since they are the only ones that are simultaneously simulated by Aquacrop OS and are compatible with local crops.

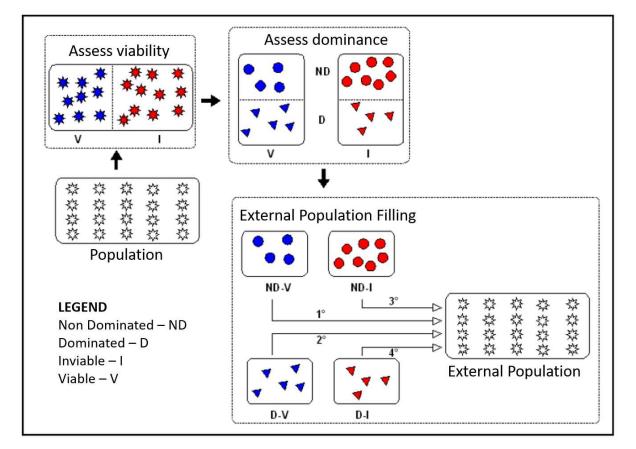
#### 4.2.10 External Population Filling

After being divided into viable and unviable, the solutions are evaluated separately into each subgroup according to the concepts of dominance and neighborhood density, discussed earlier in this work. There is also the option of evaluating individuals firstly through the concept of dominance and then dividing them according to viability. However, in this paper we chose to use the first form because, in this case, it is more important that an individual is viable than not dominated.

After separating individuals by viability and dominance criteria, the external population is filled following the order of priority listed below and illustrated in Figure ??. If it is not possible to allocate all individuals from the same subgroup into the external population, priority will be given to those with the lowest *Fitness* value.

- 1. Viable and non-dominated individuals
- 2. Viable and dominated individuals
- 3. Inviable and non-dominated individuals
- 4. Inviable and dominated individuals

Figure 8 – External population filling according to the concepts of viability and dominance. Source: (??)



## 4.2.11 Selection of Individuals and Genetic Operators

The Tournament Method was used to select individuals for reproduction. This method begins randomly selecting two individuals from the external population, choosing the most suitable between this two and forwarding it to the reproduction mechanism. To determine which individual is more fit, we used the same criteria that was utilized to fill the external population as shown in Figure ??. Thus, the best individuals and those who are in greater quantity in population are more likely to generate offspring.

The genetic operator used in this work was *Crossover* average (??). In this operator, the son is generated by the arithmetic mean of his two parents, as shown by Equation ??. As in this work the solutions could only assume integer values, if the result is a decimal number, then it is rounded to the nearest integer.

$$Son_{i,j} = round\left(\frac{Father_{i,j} + Mother_{i,j}}{2}\right)$$
(4.9)

Where:

 $Son_{i,j}$  is the element of line *i* and column *j* of son solution

round() is the function that rounds a decimal number to its nearest integer  $Father_{i,j}$  is the element of line i and column j of father solution  $Mother_{i,j}$  is the element of line i and column j of mother solution

Both the genetic operator and the mutations were associated with a probability of occurrence. As in nature, reproduction by *Crossover* had a high probability of occurrence, while mutations had low probability. If the probability of occurrence was not met, the reproduction would not occur and the son would be considered as a identical copy of his father or mother (the one who had the highest fitness considering the same criteria previously mentioned).

Two types of mutation were used, one is a uniform mutation and the other is a directed mutation. The uniform mutation could be applied to all individuals if, of course, the probability of occurrence was met. Directed mutation was applied only to unviable individuals, in order to accelerate the convergence of the algorithm.

If the probability of occurrence of the uniform mutation would been met, the son solution was entirely replaced by a random solution generated in the same way as the individuals of the initial population, as explained in session ??.

Directed mutation, unlike uniform mutation, was not applied to the sons, but to the parents. If the probability of occurrence of the mutation was reached and one of the parents was not viable, this individual was modified as shown by Equation ??.

$$Father_{i,j} = round \left( Father_{i,j} - (Father_{i,j} - IniConfig_{i,j}) * k \right)$$
(4.10)

Where:

 $Father_{i,j}$  is the element of line *i* and column *j* of father/mother solution

round() is the function that rounds a decimal number to its nearest integer

 $IniConfig_{i,j}$  is the element of line i and column j of study area current configuration matrix

k is a random number between 0 and 1.

This mutation works by lowering the cost to implement the adaptation strategy while decreases the reduction in water footprint. Thus, an solution that was previously considered unviable, because it had a higher cost than the previously established budget, may now be viable. However, a viable individual under the second constraint (which considers unviable all individuals who has demand greater than availability), may become unviable. There is no directed mutation that can act simultaneously in favor of both constraints, since an improve in one represents an worsen in the other. In our case, it is more difficult to obtain solutions that comply with restriction 1 (cost) than with restriction 2 (availability), so it was decided to implement a mutation that would lower the cost, even if this would lead to an increase in demand.

#### 4.2.12 Termination Criteria

The termination criteria defined is quite simple. The algorithm continues to make interactions (generations) indefinitely until the first viable solution is found, after that a predefined number of interactions (generations) are performed before the algorithm stops.

#### 4.2.13 Seeding

A well-known heuristic technique in genetic algorithms used to accelerate the convergence process is *Seeding*. The *Seeding* process involves inserting one or more than one solutions that are potentially good candidates for solving the problem into the initial population (??). In this work, two simulations were made, one with *Seeding* and one without it, to determine if the use of this technique would produce any significant difference in the algorithm performance. The simulations were done in duplicate to ensure that the method converged.

Comparing simulations results with and without *Seeding*, it can be observed that the use of this technique made no difference in the number of generations, in other words it did not decrease the processing time. This may be due to the fact that directed mutation is already accelerating this process, making *Seeding* not very effective.

Looking at the Pareto frontier graphs without (Figure ??) and with *Seeding* (Figure ??), no significant difference could be seen between them. The use of *Seeding* may have helped the algorithm explore more search space locations, slightly improving the diversity of the solutions, but it did not cause a significant improvement of the final result.

Given these results, it was decided not to use *Seeding* in the next simulations, since it was seen that in this case this technique does not make significant difference in the algorithm performance and in the final results.

#### 4.2.14 Elitism

Similar to *Seeding*, Elitism is another technique widely used to improve the performance of genetic algorithms. Elitism, in its essence, consists of allocating the best individuals of the current population directly into the next generation (without they having to go through the genetic operator mechanisms). This technique is used to preserve the best solutions found so far (??).

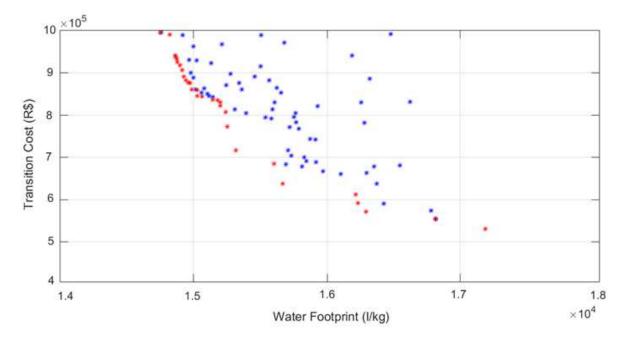
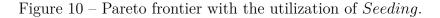
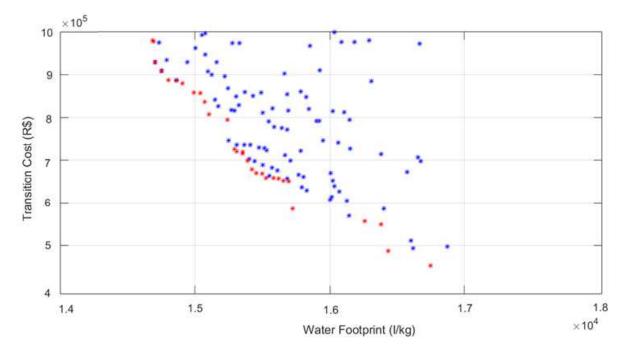


Figure 9 – Pareto frontier without the use of Seeding.





To test if the use of this technique would produce any significant difference in the algorithm performance, simulations were performed without and with the use of elitism. In those who used it, several numbers of individuals that pass directly to the next generation were tested (10, 50, 100, 150 and 200 individuals) in order to determine the optimal number of individuals.

Figure ?? shows that without the use of Elitism the Pareto frontier could not be

formed, since the algorithm converged to a single solution. So to prevent the happening of this problem, it is necessary to allocate the best solutions directly to the next generation.

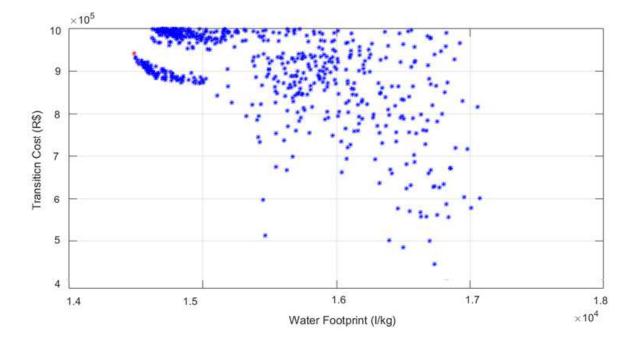
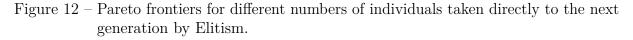




Figure ?? shows the Pareto frontiers for different numbers of individuals taken directly to the next generation by Elitism. Based on the analysis of these graphs, it is possible to conclude that the case ??, where 50 individuals were used, was the one that presented the best result and, therefore, will be used from now on in the next simulations.

## 4.3 Optimization model

In the current research, an adaptation strategy in the agricultural sector is defined as all the potential changes or measures that a user can adopt in order to compensate the negative effects of climate change. The users can increase the water use efficiency/sustainability (changing to a more efficient irrigation method or adopting improved soil/crop management that requires less water) or reduce the crop area to consume less water, causing an undesirable effect of reduction in food production. Users will reduce crop area only if the strategy of the increase of water use efficiency/sustainability does not produce the expected results. The adaptation strategy is generated in several time steps. For the generation of each step, an optimization adaptation algorithm is executed once; in other words, the algorithm is designed to provide the answer for a single step and not for the complete adaptation strategy (set of all the steps) at once (Figure ??). The proposed method helps to determine the way that the users should evolve the water usage from the current situation to the ideal situation (step by step), considering their living environment.



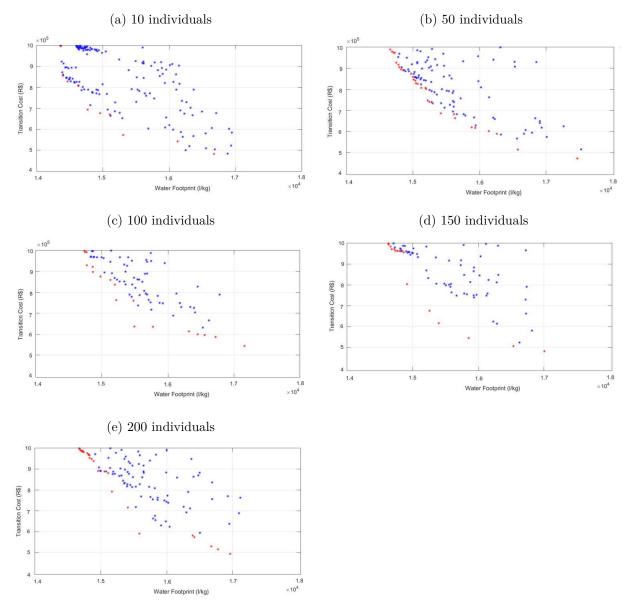
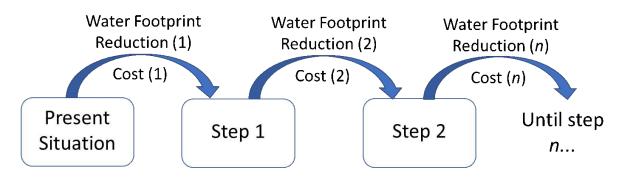


Figure 13 – Structure of the adaptation strategy produced with the proposed methodology.



The size of the time interval considered in each step may be different (1, 2, 5, 5)10 years, etc.). Thus, the methodology users', e.g. the local water resources managers, can select the time period for achieving specific goals. Since each step is processed by a different optimization, these time ranges may also differ at each optimization step. It is also possible to consider additional changes, such as the climate, the users and the study area at each step, making the adaptation process much more flexible and dynamic. In the current research, the total time interval was defined from 2020 to 2070 and the time step was 10 years, hence the adaptation strategy was subdivided into 5 steps. Estimations about the last year of the decade were used to represent and product the results for the entire decade, since the strategies represents what should be done during the entire decade to reach its end adapted to the impacts of climate change that it is expected to occur within that same decade. After the completion of the first optimization set, one of the non-dominated solutions is selected as the starting point of the next optimization, which aims to determine the best strategies that are going to be used in the next step of the adaptation process, and so on. On the ground, this choice could be done by the farmers according to their interests. Since none solution is better than the other, one solution was picked randomly and was considered as if it was the farmer's choice, so the optimization process could be triggered.

# 5 Application

The Gramame river basin is located between latitudes  $7^{\circ}C11'$  e  $7^{\circ}C23'$  South and the longitudes  $34^{\circ}C86'$  e  $35^{\circ}C10'$  West on the southern coast of the state of Paraíba, Northeast of Brazil, as shown in Figure ??. This basin is considered strategic due to its importance to the region. In it is inserted the main reservoir from the coastal region of the state, Gramame-Mamuaba. This reservoir is responsible for supplying water for the capital of the state of Paraíba, the city of João Pessoa, which there are 720,954 inhabitants according to ??). In addition, the Gramame reservoir serves as a water source for irrigation (??).

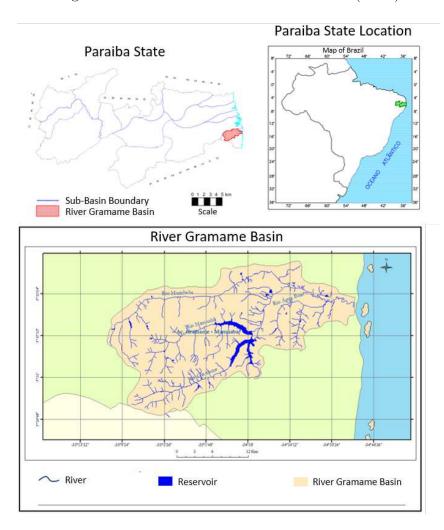


Figure 14 – River Gramame basin. Sources:(????)

Within the Gramame basin there are three sub-basins: river Mumbaba sub-basin, river Mamuaba sub-basin and river Água Boa sub-basin. Gramame basin area as well as the area of its sub-basins can be seen in Table ??.

Basin / Sub-basin	Area
Gramame Basin	589,1
Mumbaba Sub-basin	177,2
Mamuaba Sub-basin	128,0
Água Boa Sub-basin	65,4

Table 1 – River Gramame basin and its sub-basins areas. Source:(??)

#### Socio-economic characterization

The Gramame River basin is composed of the municipalities of Alhandra, Conde, Cruz do Espirito Santo, João Pessoa, Santa Rita, São Miguel de Taipu and Pedras de Fogo. The percentages of basin area participation by municipality are shown in Table ?? and the political map of the basin is shown in Figure ??.

Table 2 – Participation of each municipality on the basin. Source: (??)

Municipality	Municipality Area (km <sup>2</sup> )	Municipality Area on basin $(km^2)$	Participation (%)
Alhandra	224,42	99,72	16,93
Conde	164,10	76,47	12,98
Cruz do Espírito Santo	189,32	3,50	0,59
João Pessoa	209,94	59,07	10,03
Santa Rita	762,33	155,59	26,41
São Miguel de Taipu	63,60	2,20	0,37
Pedras de Fogo	348,02	192,56	32,69

According to ??), the main economic activities of the basin are:

- Agricultural Activities: It is the main economic activity of the basin, besides being the largest consumer of water. There are more than 100 irrigation projects, from the most varied sizes. Sugar cane and pineapple are the crops with the largest irrigated areas.
- Industrial Production: Most industries are in the industrial district of João Pessoa.
- Mining: There is exploration of sand, clay, limestone and mineral water.
- **Tourism and Leisure:** They are concentrated in the lower part of the basin, near the coast.

#### Land use and cover

This region is historically marked by an intense process of deforestation, both by the logging industry and for intensive sugarcane planting (??). With regard to land

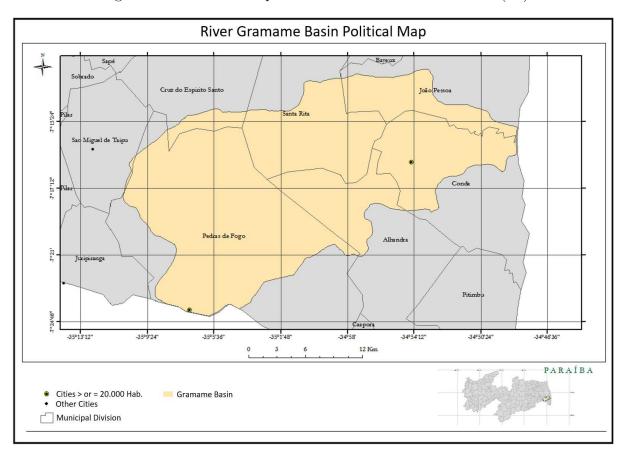


Figure 15 – Political map of river Gramame basin. Source:(??)

cover, only 12.9% of the basin area still contains native land cover, the remained area was anthropomorphized. It is possible to check it in the Table ?? which shows land use and land occupation in 1998.

Land use and cover	Area (ha)	Percentage
Atlantic Forest	3.820	6,5
Cerrado	1.137	1,9
Lowland Vegetation	2.074	$^{3,5}$
Mangrove Vegetation	613	1,0
Anthropism	51.266	87,1
Sum	58.910	100,0

Table 3 – Basin land use. Source: (??)

### $\mathbf{Soil}$

The main rivers of the basin have their springs located in its southwestern part, which is characterized by the presence of a crystalline complex where there is occurrence of faults and fractures in the rocks. From this point on, rivers begin to develop in sloping valleys extending to the eastern part of the basin. Because of this characteristic, the springs are located in areas of low water availability. The perennialization of rivers only occurs from the moment they reach the high water potential sedimentary soil (??).

Looking at the soil map of the basin (Figure ??), it is possible to realize that the predominant soil in the Mamuaba River sub-basin is the Hydromorphic Podzol. This type of soil is sandy and deep, with a high infiltration rate and low water retention. In addition, it is known to be a soil with retarded runoff (??).

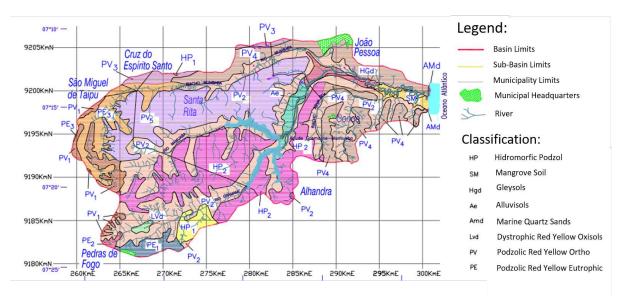


Figure 16 – Pedological map of the Gramame river basin. Source: (??)

### Climate characteristics

The Northeast region is characterized by a strong intra and interannual variability of the rainfall, with alternations between dry and rainy periods (??). In the study area, the dry season usually starts in September and ends in February and the rainy season usually begins in late April and ends in the end of July, with the other months having intermediate characteristics. Figure ?? shows months of occurrence of dry, wet and rainy periods, as well as precipitation and average daily evapotranspirations for the study area.

According to ??), the average annual basin evapotranspiration is about 1312.5mm, while its average annual rainfall is around 1740mm. Using the FAO local climate estimator (New LocClim 1.10) (??), it was possible to obtain the monthly averages of precipitation and potential evapotranspiration in the basin, which can be seen in Figure ??.

The geographical position of the state of Paraíba, close to the equator, the high incidence of solar radiation and the high number of hours of sunshine are determining factors for the occurrence of a warm climate, with an average annual temperature of 26.1  $^{\circ}C$ , according to ??).

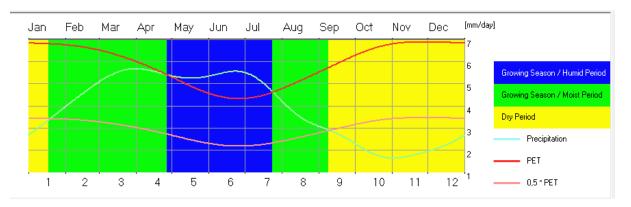
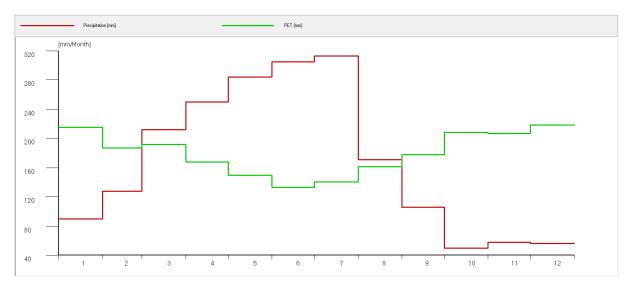


Figure 17 – Dry, wet and rainy periods in the study area. Source: (??)

Figure 18 – : Monthly averages of precipitation and evapotranspiration for Gramame river basin. Source: (??)



Climate data can be obtained from João Pessoa weather station, which is in a short distance from the Gramame river basin. This climatological station is managed by the National Institute of Meteorology of Brazil (INMET), which makes all data freely available on its site.

Daily data on sunshine, precipitation, radiation, minimum and maximum temperatures, humidity and wind speed (obtained both from FAO's local climate estimator and INMET), were treated and inserted in AquaCrop software to obtain a reference evapotranspiration estimation (essential data for the functioning of AquaCrop OS). Following this process, reference evapotranspiration, together with precipitation and maximum and minimum temperatures (all data on the daily scale), were used to feed the AquaCrop OS weather data input file. These data is presented on Annex ?? for each decade. Data for precipitation, temperature, and evapotranspiration changes from one decade to another to simulate the climate change effect (this topic will be better discussed forward in this chapter).

#### Water users

On this research, only the farmers present in the River Mamuaba basin were considered. Figure ?? shows the location of this basin , within the Gramame basin. In this same figure, we can still see the location of farmers within the basin according to the size of the area irrigated by them.

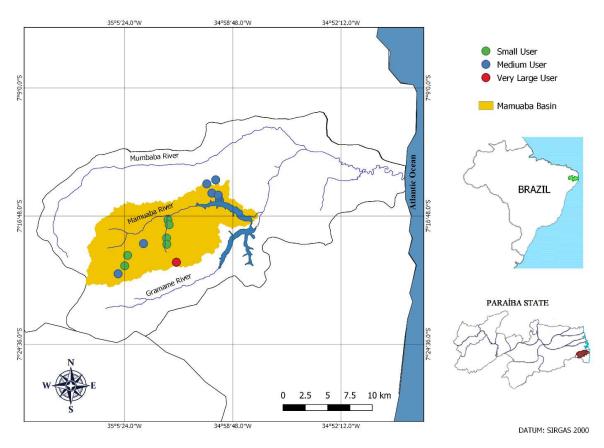


Figure 19 – Farmers location.

A register of farmers made by ??) (Table ??) was used as a basis for the characterization of the farmers, although these data are out of date and no longer represent the reality of the basin, it serves as a scenario to test the operation of the proposed method.

Despite the farmers names are present in the original source, these were omitted and replaced by numbers in this work. Depending on the size of the area irrigated by each user (A), these were classified as: Very small (A < 5ha), small (5 < A < 10ha), medium (10 < A < 50ha, large (50 < A < 100ha) or very large (A > 100ha). The intervals presented above are the same intervals used by ??) to classify the farmers based on the area irrigated by them. In addition to this information, the Table ?? contains information about the crop, geographical coordinates, and the irrigation method used to irrigate each crop. None of the farmers utilizes any type of mulching or cover crop (at least we do not have any source informing about the utilization of this kind practice by the farmers in the study area), so all farmers are labeled with the "no mulching" status.

The water demands for each user were also reported by ??), but since AquaCrop OS could calculate them, it was preferred to use the demands obtained by AquaCrop OS, because them would have to be recalculated anyway at all stages of optimization in order to take into account the increases in demands caused by the impacts of climate change.

Although the user's data is outdated (the data is from approximately 20 years ago), we believed that this is not a problem for our research. That is because, it is not the intention of this work to produce an adaptation strategy for the area in question, but rather, to present an innovative methodology for the creation of this type of strategy, which can be used in various types of cases and locations. Therefore, the application in the Mamuaba basin has only an expository aspect of how the methodology works in practice. In addition, even if current data on the study area were used, we believe that the final result will not differ much from that obtained, since, although the absolute values vary over time, the relationships between different values remain more or less constant (dripping irrigation will always be more expensive than conventional sprinkler), so that the trends (which, in the end, are what guide the adoption of adaptation strategies) remained the same. In other words, it doesn't matter if the simulation starts with data from 2000 or 2020, it will tend to similar results when it arrives in 2070.

Besides irrigation, water is also used for other purposes in the basin. In Table ?? is possible to see all cities that use water from the basin to urban population supply, as well as the respective demand value in l/s. Table ?? shows, for each sub-basin, the demand for rural population and industry supply in  $m^3/s$ . Those values of demand, from both tables, are estimations made by ??) for the year of 2020.

Farmers	Crop	Area (ha)	Classification	Coordinates UTM (km)	Irrigation Method
1	Pineapple	30	MEDIUM	(279,9198)	Conventional Sprinkler
1	Pineapple	42	MEDIUM	(278,9198)	Center Pivot
2	Pineapple	4	SMALL	(274,9191)	Conventional Sprinkle
2	Yam	1,4	SMALL	(274,9191)	Conventional Sprinkle
3	Yam	1	SMALL	(274,9193)	Conventional Sprinkle
3	Pineapple	1	SMALL	(274,9193)	Conventional Sprinkle
3	Coconut	1	SMALL	(274,9193)	Conventional Sprinkle
3	Orange	1	SMALL	(274,9193)	Conventional Sprinkle
4	Pineapple	2,5	SMALL	(273,9192)	Conventional Sprinkle
4	Manioc Tree	2,5	SMALL	(273,9192)	Conventional Sprinkle
5	Beans	1	VERY SMALL	(274,9194)	Conventional Sprinkle
5	Corn	1	VERY SMALL	(274,9194)	Conventional Sprinkle
5	Yam	2	VERY SMALL	(274,9194)	Conventional Sprinkle
6	Beans	1	VERY SMALL	(269,9190)	Conventional Sprinkle
6	Yams	1	VERY SMALL	(269,9190)	Conventional Sprinkle
7	Pineapple	16	MEDIUM	(279,9197)	Center Pivot
7	Papaya	16	MEDIUM	(279,9197)	Center Pivot
8	Sugar Cane	600	VERY LARGE	(276,9186)	Giant Canon
9	Pineapple	15	MEDIUM	(279,9197)	Center Pivot
10	Pineapple	15	MEDIUM	(279,9196)	Conventional Sprinkle
10	Papaya	1	MEDIUM	(279,9196)	Conventional Sprinkle
11	Pineapple	1	SMALL	(269,9189)	Conventional Sprinkle
11	Yams	2	SMALL	(269,9189)	Conventional Sprinkle
11	Beans	2	SMALL	(269,9189)	Conventional Sprinkle
12	Pineapple	10	MEDIUM	(268,9188)	Conventional Sprinkle
13	Pineapple	10	MEDIUM	(271,9191)	Giant Canon
13	Sugar Cane	32	MEDIUM	(271,9191)	Giant Canon

Table 4 – Irrigators from the Mamuaba River Sub-basin. Source: (??)

Table 5 – Espected demand for urban population in 2020. Source: (??)

Municipalities	Urban Population Demand $(l/s)$
Bayeux	436,69
Cabedelo	292,16
João Pessoa	3.066,95
Conde	27,35
Pedras de Fogo	21,25
Várzea Nova	69,59

Table 6 – Espected demand for industries and rural population in 2020. Source: (??)

	Demand $m^2$	$^{3}/s$
Sub-basin	<b>Rural Population</b>	Industries
Água Boa	3.45	15
Gramame	7.90	244
Mamuaba	3.98	1
Mumbaba	5.74	629

### Demand and Water Availability

The water availability of a basin represents the quantification of the water resources

within that basin without human intervention, i.e. in its natural state. It is represented by the arithmetic mean of the natural flows historical series. Its value indicates the theoretically maximum average flow rate that could be withdrawn from that basin. However, according to ??), the maximum amount that can be made available for water use corresponds to a fraction of typically 60% of that maximum average flow rate. Table ?? shows the water availability of the Gramame basin and its sub-basins.

Basin or Sub-basin	Availability $m^3/s$
Mamuaba Sub-basin	1,83
Mumbaba Sub-basin	2,38
Riacho da Salsa Sub-basin	0,51
Água Boa River Sub-basin	1,28
Gramame Basin	9,50

Table 7 – Water availability in River Gramame Basin. Source: (??)

For Mamuaba sub-basin, where the farmers presented on Table ?? are, the availability is  $1,83m^3/s$ . If we multiply this value for the 60% fraction that is suggested by ??), we only stay with approximately  $1,0m^3/s$  for human use. In this work, we had considered the last value as the sub-basin water availability.

IPCC-derived projections for Brazil (??), considering scenario RCP 4.5 of Eta-HadGEM2ES model for the 2041-2070 period, were used to estimate future values of precipitation, air temperature, and water availability for each decade (step), considering the current conditions as the baseline (2020-2030). According to the projections, it is expected a:

- Reduction of 50 mm of surface flow until 2070;
- Increase of 6.7 °C (mean temperature) until 2100;
- Decrease of 22% on precipitation until 2100;

To estimate the reduction on water availability in the future decades, the reduction of the surface flow was considered to occur steadily on the 2020-2070 period. This can be considered a source of uncertainty and imprecision for the work, since, in practice, this dynamic occurs in a much more complex way. However, for the purposes of this research, the approximation that was made is considered satisfactory. To convert the reduction in surface flow into flow reduction (which is the parameter used to measure water availability), the water depth was multiplied by the area of the mamuaba basin and then divided by the simulation period.

Reductions in precipitation and increases in temperature were used to estimate the increase in demand, since both contribute to increasing the demand for water for irrigation.

To make this estimation, the Aquacrop software was used, since it is able to calculate the demand for irrigation. All other parameters were kept constant, while temperature and precipitation were changed to reflect the expected changes. Other parameters considered in the AquaCrop modeling process, like duration of sunshine, net solar radiation, air humidity, and wind speed were considered constant during the whole process because we can not find any prediction about the behavior of those variables along this period. This simplification is another possible source of uncertainties for the work, as some of the variables considered constant may vary over time, however, for the same reasons already mentioned above, we believe that these uncertainties did not affect the quality of the final results of the work.

#### **Adaptation Cost**

A survey on various irrigation methods was preformed in order to collect the following data: percentage of wetted soil, irrigation method efficiency, and cost estimate for implementing the method per unit of area. This survey included both the methods that are already used in the study area, as well as methods that are more efficient than those that may replace the current ones in the adaptation process. Table ?? shows a summary of those information (???????).

Irrigation Method	% of wetted soil	Method Efficiency	Cost $R$ / $hc$
Conventional mobile sprinkler	100	70%	1500
Sprinkler with mini cannon	100	60%	2200
Sprinkler with giant cannon	100	50%	Not necessary
Center pivot	100	80%	3000
Micro sprinkler	40	90%	8000
Dripping	15	95%	8000

Table 8 – Information about the irrigation methods.

Similarly, information on soil management methods was collected in order to know the following data: reduction of water evaporation from the soil surface caused by the management practice, and estimated cost to implement the method per unit of area. Among the farmers considered, none used soil management practices, so all the surveyed methods are suggestions for future adoption during the adaptation process. Among all practices, only the mulching practices were considered, since they are the only ones that are simultaneously simulated by Aquacrop OS and are compatible with local crops. Table ?? shows a summary of those information (?????).

Similarly to user's data, cost information is also out of date and has uncertainties in its estimation process (old production dates, sources from other parts of the country, produced for different cases at different time periods, uncertainties already present in the original sources), however, for the same reasons already exposed in the topic about user's

Soil Management Methods	% reduction on soil evaporation	Cost $R$ %/ $m^2$
Without Mulching	0	0
Organic Mulching	50	0.05
Plastic Mulching	100	0.1

Table 9 – Information about the soil management methods.

data, it was considered that, despite all these uncertainties, the credibility of the results obtained was not impaired.

### 5.1 GA Parameters

In this work, we used the following parameters in the evolutionary algorithm:

- Population: 500 solutions
- External population: 200 solutions
- Probability of occurrence of *Crossover* : 80%
- Probability of occurrence of uniform mutation: 30%
- Probability of occurrence of directed mutation: 10%
- Number of simulated generations after the appearance of the first viable individual: 1000 generations

These parameters were kept constant during all simulations and were defined based on the usual values found on literature and tests performed on the algorithm itself (trial and error).

## 6 Results and Discussion

The algorithm was used to generate an adaptation strategy to climatic change to a group of farmers in the river Mamuaba sub-basin, that are already mentioned in the Study Case topic. The time interval considered was from 2020 to 2070 and the time step considered was 10 years hence the adaptation strategy was subdivided into 5 steps.

The results will be presented and discussed within five different sub-topics:

- 1. Climate change impacts: In this topic are going to be presented the predict impacts of climate change (that the adaptation strategy will need to compensate for).
- 2. Adaptation strategy: Here will be presented the main results of this work and the general recommendations for the farmer extracted from these results.
- 3. Equity and adaptation: Here we will show an analysis of the adaptation strategy from the water justice point of view
- 4. Crops x irrigation methods x soil management: Here we will present a general recommendation for adaptation, for this particular study case, with regards to the many adaptations options that are available.
- 5. Setting water footprint benchmarks: Here we will use some results extracted from the main results to recommend water footprint benchmarks to the time interval considered (2020 2070).

## 6.1 Climate Change Impacts

Using the projections from ??) it was possible to make estimatives of the reference evapotranspiration for each time step. With this estimative, we could use Aquacrop to estimate how the demand for water for irrigation would increase. Figure ?? shows how water availability will decrease according to ??) and how the demand for water for irrigation in the study area will increase according to the estimative obtained through AquaCrop.

From the results shown above, the increase in mean temperature caused by climate change will lead to an increase in evapotranspiration, as well as an increase in the agricultural demand for water. The decrease in precipitation also causes an increase in demand since more irrigation water will be necessary to supply the deficit between the amount of rainfall and the water demand for crop growth.

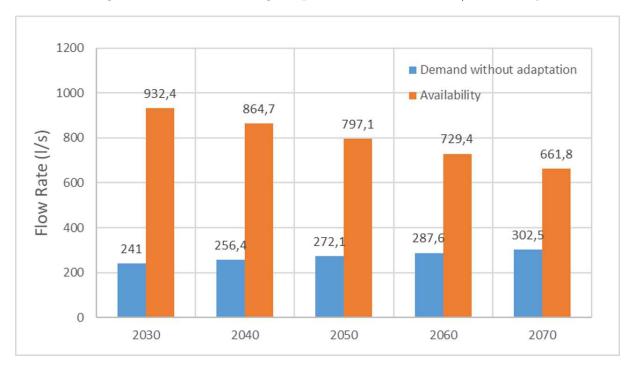


Figure 20 – Climate change impacts on water demand/availability

On the water availability side, the reduction in surface flow will culminate with a reduction in the river's streamflow, consequently reducing the availability of water. So we could see that the adaptation strategy will have to compensate not only for the reduction in availability but for the increase in water demand as well.

At Brazil, we have similar studies pointing out to analogous results. According to ??) climate change is concluded to have an enormous potential impact on the Semi-arid region of Brazil, with this phenomenon especially effecting river flow, water storage and irrigated production (even under plausible favorable changes in climate, these variables remain stressed). ??) analyzed the impacts of climate changes on the flow and sediment production regimes in the Concórdia River drainage basin, in southern Brazil; the analysis shown a reduction in flow of 39.2% in the most favorable scenario and suggested that flood peaks could reach more extreme values in the future. ??) discussed the influence of climate change and societal setting upon the value of forecasts of streamflows that replenish reservoirs in the semi-arid state of Ceará, Brazil, and they concluded that water demand for high-economic value activities are likely to increase in the future. According to ??), is expected an increase in the dryness of the Northeast Brazil region, with rainfall reductions, temperature increases, water deficits increases and longer dry spells, leading to drought and arid conditions expected to prevail by the second half of the 21th century. ??) examined the implications of changes in crop water demand and water availability for the reliability of irrigation; the study takes place in several countries, including Brazil, and the conclusions were that even in the relatively water-rich areas changes in water demand

will require appropriate improvements in crop cultivars, irrigation, drainage technology, and water management.

??) evaluated the effect of futures changes in precipitation and temperature distributions in the availability of water resources for agriculture in north-western Africa, region that, as the study area of this work, also have trends of decreasing precipitation and increasing temperatures; simulation results from this work also pointed out increasing demands and decreasing water availability that, in this particular case, will cause until 2050 the tripling of the basin water deficit.

## 6.2 Adaptation Strategy

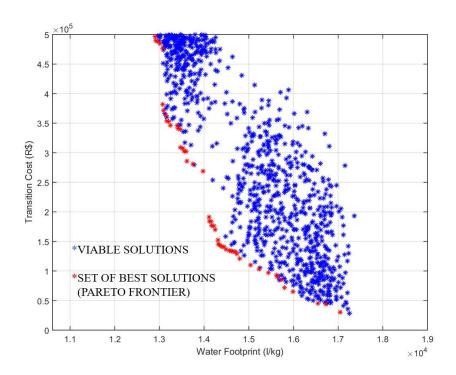
Figure ?? shows the adaptation strategy generated by the genetic algorithm. That table alone says very little, but from it is possible to extract some valuable secondary data and conclusions, for instance: reduction on water footprint in each step, if small farmers were prioritized or not, and general recommendations for the farmers. All this secondary data will be presented and discussed in details on the next sections.

strategy.
Adaptation
Figure 21 –

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## 6.3 Pareto Frontiers

Figures ?? to ?? presents the Pareto Frontiers of all optimizations, one for each period/decade. From these graphs, we can see that there is one adaptation strategy for each amount of money invested which produces the best final result in terms of a reduction in total water footprint. Other works have already done similar cost-effectiveness approaches, as ??) that made a cost-effectiveness analysis of four water-saving irrigation techniques that are widely implemented in China, and concluded that water-saving irrigation is cost-effective in coping with climate change and has benefits for climate change mitigation and adaptation and for sustainable economic development. ??) also performed a cost-benefit analyses finding the most effective strategies to cope with climate changes impacts in River Thames basin in southern England. ??) made marginal cost curves (MCCs) to rank packages of water saving techniques (deficit irrigation, mulching, and changing irrigation methods) according to their cost effectiveness to reduce the water footprint need to support the decision making.





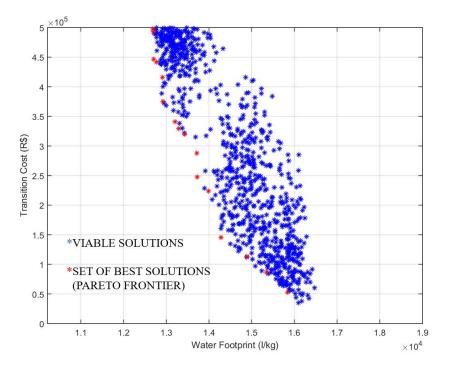
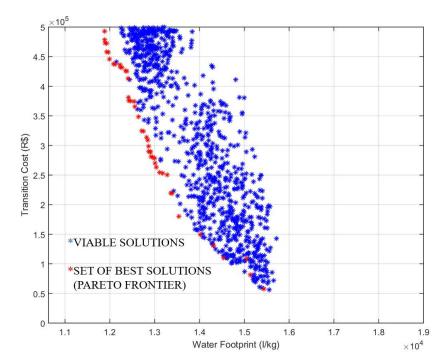


Figure 23 – Pareto Frontier for 2030 – 2040 period

Figure 24 – Pareto Frontier for 2040 – 2050 period



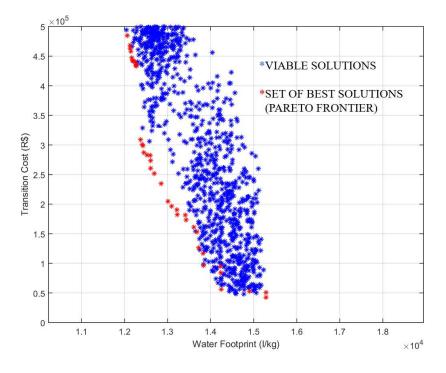


Figure 25 – Pareto Frontier for 2050 – 2060 period

Figure 26 – Pareto Frontier for 2060 – 2070 period

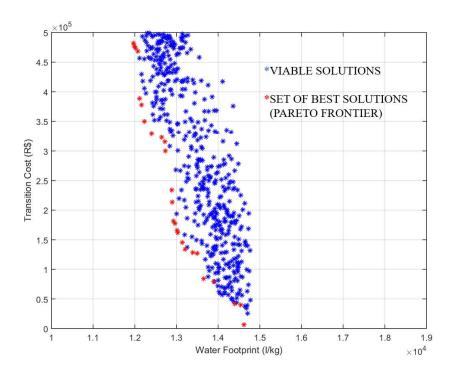


Figure ?? shows, in a single graph, the Pareto Frontiers of all periods, demonstrating that there is an evolution in sustainability/efficiency in water use across time because

of the measures taken on the previous decades, showing that the process of adaptation occurs in an evolutionary way.

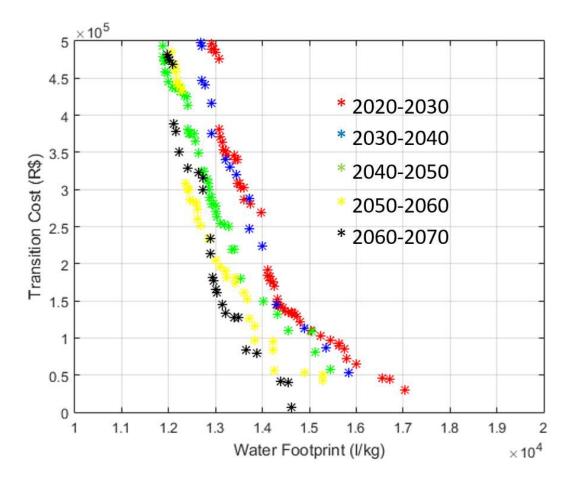


Figure 27 – Pareto frontiers of all periods.

Similar sequential multiobjective optimization were already done in several other works, mainly with the objective of saving processing time on complex problems with substantial number of decision making variables (????????). In these works, a complex optimization problem was subdivided into simpler ones, which, if solved in a sequential manner (with the result of the previous one serving as a starting point for the next optimization), it provided an approximate result for the more complex problem. Although the solution is being improved in each step, the goal remains in finding the final result. The method becomes attractive because it is faster.

In our case, the sequential optimization process was slightly different, firstly because the optimization problem was not simplified (as we were not interested in reducing the processing speed) and secondly because great importance was given to the intermediate stages (the evolution of the solution itself). This is a kind of solution that does not only care about the final result but, instead, gives to the transition process the same attention that is given to the final result. According to ??), more attention has to be devoted to understanding and managing the transition from current management regimes to more adaptive regimes that take into account environmental, technological, economic, institutional and cultural characteristics of river basins. It means that we have to move from a prediction and controlled water management to a more learning management, where more attention is given to local characteristics (????).

The Pareto Frontier can be a powerful tool to assist in the decision making process for water and environmental problems, having already been used for this purpose in several works (??) (????). Furthermore, all Pareto frontiers were analyzed in order to identify any potential pattern that could serve as a general recommendation to the farmers at each time period. Thus, for all the decades, except for the last one, it's obvious that the Pareto frontiers can be decomposed into two lines: one bottom line that is more horizontal, and an upper line that is more vertical (Figures ?? to ??). That behavior shows that, until a certain cost (the intersection of the lines), the reduction in water footprint per unit of money invested is more gainful than beyond that point. The intersection point can be a good, simplified and general recommendation for the users. For instance, in the first three decades, the intersection point lies approximately at the cost of R\$ 150000, while in the fourth decade it lies on R\$300000 and in the last decade we can see only the vertical line.

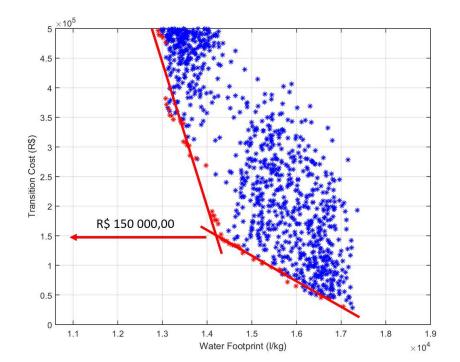


Figure 28 – Pareto Frontier general recommendation for 2020 – 2030 period

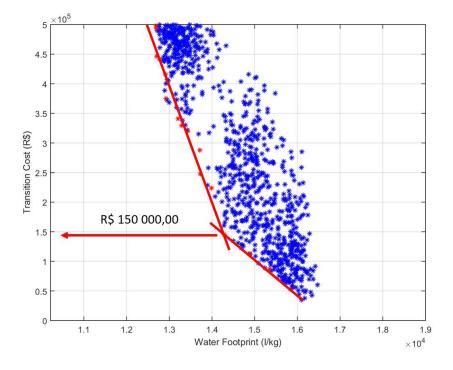
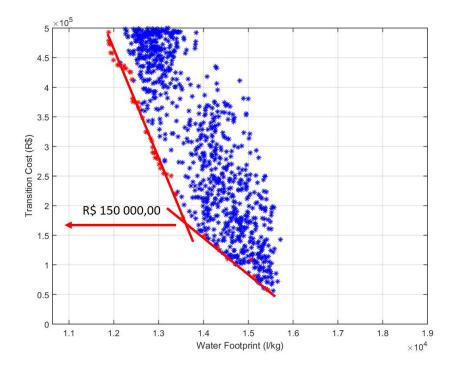


Figure 29 – Pareto Frontier general recommendation for 2030 - 2040 period

Figure 30 – Pareto Frontier general recommendation for 2040 - 2050 period



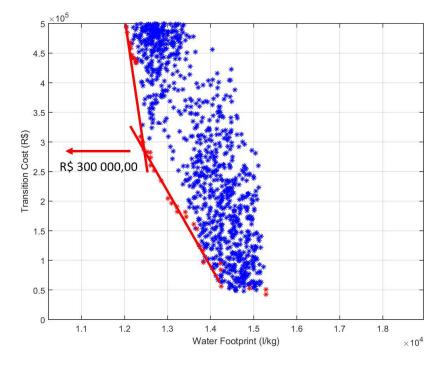
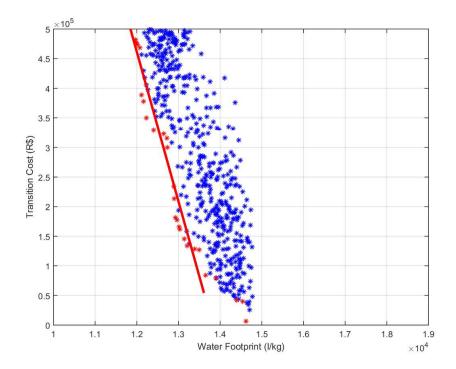


Figure 31 – Pareto Frontier general recommendation for 2050 - 2060 period

Figure 32 – Pareto Frontier general recommendation for 2060 - 2070 period



The intersection point could be a good, simplified and general recommendation for the farmers. For instance, in the first three decades, the intersection point lies approximately at the cost of R\$ 150000, while in the fourth decade it lies on R\$300000 and in the last decade we can see only the vertical line. That behavior on the Pareto frontier could be 'translated' to the farmer as: 'In the three first decades, we recommend investing R\$150000 in adaptations measures. In the fourth decade, we recommend investing the double of this value. In the last decade, the best solution is probably adopting the cheaper strategy of the Pareto frontier.'

## 6.4 Equity and Adaptation

The classification of users based on the irrigated area was not inserted explicitly in the objective functions. Despite that, the final results showed that very small users were prioritized over medium and large ones, and received more adaptations measures, as shown in Figure ??.

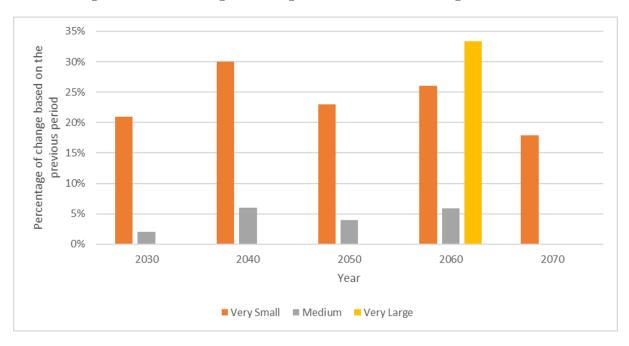


Figure 33 – Percentage of change based on farmer's irrigated area size

The way that the first objective function was written was the reason for this result. Since the first objective function is the sum of all user's WF, a specific reduction in the WF of a small user has the same impact (in the fitness value) with the similar one in a large user's WF. Reducing the WF of a large user costs more than reducing the WF of a small user, thus it is more advantageous to adapt the smaller first.

??) considers climate change as one of the factors that affects equity in naturalresource use, particularly in the developing world. So it is very important that the adaptation strategy is done in that way (prioritizing the implementation of the adaptation measures on the smaller farmers) because household farmers are much more vulnerable to climate change impacts and have much less power to respond to these impacts (??).

In the present research, we were able to group together, in one single model, three important objectives (reducing water footprint, minimizing costs and seek for equity), with two of them explicitly and one implicitly included in the objective functions. This approach is of great importance, since little has been said about the joint resolution of issues adaptation and equity issues, being necessary more holistic approaches to build community resilience (??). According to ??), finding equitable strategies are as important as to select efficient, robust, and flexible adaptation strategies.

## 6.5 Crops x Irrigation Methods x Soil Management

Figure ?? shows the number of changes proposed by the adaptation strategy grouped into three categories: changes in crop type, changes in irrigation method, and changes in soil management methods. There is a clear preference for changes in irrigation methods and soil management methods rather than changes in crop types. These outputs could easily be transferred to the users, i.e. the farmers, in order to be replicated in the field. Practically this means that the farmers should prefer measures/changes that enhance the system's efficiency than solutions that propose the replacement of cultivations that consume more water with those that demand less water. Other works also have suggested the improvement of irrigation water use efficiency (including better irrigation techniques, mulching and cover crops) as a viable option for adaption to the impacts of climate change in agriculture (???????)

This behavior can be explained by the concept of WF, which takes into consideration both water consumption and crop yield. It is possible to have a decrease in WF at the same time that is an increase in water demand. As water demand is a constraint of the algorithm, it is possible that the algorithm had given preference to changes in irrigation methods and soil management methods rather than changes in crop types to avoid increases in water demand.

This kind of pattern is useful for a series of other reasons too. For instance, changes of crop types are most difficult to be applied on the ground because of market reasons, e.g. the demand of products does not vary, certain kind of crop do not have demand on local market, and due to social/cultural reasons, e.g. farmers already have expertise on the cultivation a certain kind of crop, and they not want to change to a crop unknown to them (??).

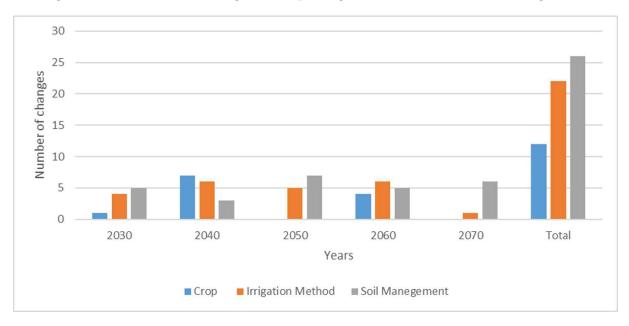


Figure 34 – Number of changes in crop, irrigation method and soil management.

## 6.6 Setting Water Footprint Benchmarks

The evolution in time of the total WF of all users, as depicted in Figure ??, demonstrates a decreasing trend. In the first years, there were bigger reductions that in the last years. This is due to the fact that the more WF is reduced the more it costs to reduce it even more (the more efficient the irrigation method is, the more expensive it is). An additional argument is that in adaptation measures, there is an initial increased cost to apply the measure, with the benefits to be more obvious in the long term, i.e. after the year 2050.

The water footprint values can serve as benchmarks to monitor the adaptation strategy implementation process on the ground. According to ??), benchmarks for the WF of crop production can serve as a reference and be helpful in setting WF reduction targets. Other authors have already set water footprint benchmarks to serve as targets in the process of reduction in water consumption (????).

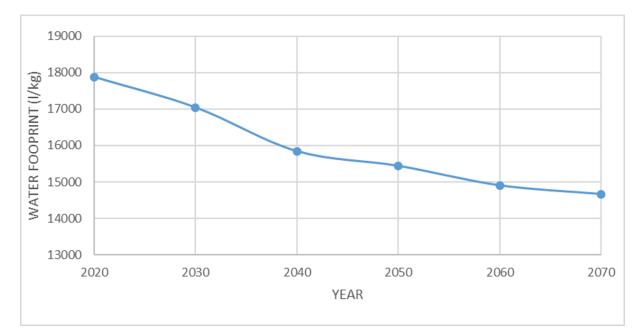


Figure 35 – Evolution of water footprint.

# 7 Conclusions

All the results obtained from this research take us to the following conclusions:

- The adaptation strategy should compensate not only for the reduction in availability but for the increase in water demand as well.
- Through the adaptation strategies, it was possible to identify general recommendations to be followed by the farmers, as:
  - 1. For the first decades, until a certain cost, the reduction in water footprint per unit of money invested is more effective than beyond that point in time. For the last decades, the best solution is probably adopting the cheaper strategy of the Pareto frontier.
  - 2. There is a clear recommendation for changes in irrigation and soil management methods rather than changes in crop types.
- There is an evolution in sustainability/efficiency in water use along time due to the measures taken in the first decades, showing that the process of adaptation occurs in an evolutionary way.
- The adaptation strategies have contributed positively to mitigate the power and opportunities differences that exists between householders and big farmers, as is possible to see that small farmers received more adaptations measures than large farmers.
- Based on local characteristics, we have set water footprint benchmarks to be used as sustainability goals in order to monitor and evaluate the adaptation strategy implementation process on the ground.
- We believe that the results and conclusions presented in this work will be especially important for stakeholders strategic decisions, in the form of supporting material to guide public policies and government investments.

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Appendix

## APPENDIX A – Source Code

```
format long
   %Number of generations
   n_ger=10;
   %number of individuals into initial population
5 n_popu=500;
   %number of individuals into external population
   n_popu_ext=200;
   %probability of crossover occurring
  p_cross=0.8;
10 | %probability of mutation occurring
   p_mut=0.3;
   %probability of occurrence of targeted mutation
   p_mut_dir=0.1;
   %number of users
15 n_usuarios=27;
   %Avaliability (l/s)
   q_100=147.9;
   q_100=q_100/1000; %m3/s
   %Number of crops
20 n_crop=6;
   %Number of irrigation methods
   n_irrig=6;
   %Number of soil management methods
  n_mane=3;
25 & Cultivation time of each crop (days)
   t_days=[90 120 364 90 90 120];
   t_sec=t_days*24*60*60;
   %number of objective functions
  n_funcoes=2;
30 %budget
   custo_limite=500000;
   %Cost (R$/m2)
   cost=[0 0 0 0 0 0
        0 0.22 0.15 0.3 0.8 0.8 % cost to change irrigation method
35
        0 0.05 0.1 Inf Inf Inf]; % cost to change mulching practice
```

```
% Initial Configuration
40
   SUsers configuration at the beginning of the period
  IniConfig= [6 6 6 5 5 6 5 5 6 5 1 6 6 1 5 6 4 4 6 6 2 6 5 3 6 6 3
  4 4 4 5 3 5 4 4 5 4 4 5 4 3 5 4 4 1 4 3 4 4 5 4 3 1 1
  1 1 2 1 1 2 2 1 2 2 1 1 3 2 3 1 1 1 1 3 3 2 2 3 2 2 1];
45
   %Maximum values that the solution can assume (used in reproduction,
     \hookrightarrow to avoid the birth of unviable children)
  50
   %Maximum area per user (m2)
  A max=[300000 420000 40000 14000 10000 10000 10000 10000 25000 25000 10000
     \hookrightarrow 10000 \ 20000 \ 10000 \ 10000 \ 160000 \ 160000 \ 6000000 \ 150000 \ 150000 \ 10000 \ 10000
     \hookrightarrow 20000 20000 100000 100000 320000];
   55
   %generating initial population
   popu_inicial=zeros(3,n_usuarios,n_popu);
  for k=1:n_popu
      for j=1:n_usuarios
60
         for i=1:3
            if i==1
            popu_inicial(i,j,k)=IniConfig(i,j)+round((n_crop-IniConfig(i,j))*
               \rightarrow rand(1));
            elseif i==2
            popu_inicial(i,j,k)=IniConfig(i,j)+round((n_irrig-IniConfig(i,j))*
65
               \leftrightarrow rand(1));
            else
            popu_inicial(i,j,k)=IniConfig(i,j)+round((n_mane-IniConfig(i,j))*
               \rightarrow rand(1)):
            end
         end
70
      end
   end
  for k=1:n_popu
      popu_inicial(1,:,k)=IniConfig(1,:);
```

```
75
   end
    %Water footprint estimation
  matriz_PH=zeros(n_crop,n_irrig,n_mane);
80
   matriz_TotIrr=zeros(n_crop,n_irrig,n_mane);
   for cropt=1:n_crop
   for irrig=1:n_irrig
   for mane=1:n_mane
85
   if cropt==1
    %Dry Bean
   crop={'Maize'};
   for i=1:1
90 fid2 = fopen('Crop.txt','wt');
   fprintf(fid2,'%%%% ------ Crop parameters for AquaCropOS ----- %%\n');
   fprintf(fid2,'%%%% Crop Type (1: Leafy vegetable, 2: Root/tuber, 3: Fruit/grain
       \rightarrow ) %%\n');
   fprintf(fid2,'CropType : %f\n', 3);%
95 [fprintf(fid2,'%%%% Calendar Type (1: Calendar days, 2: Growing degree days)\n')
       \hookrightarrow:
   fprintf(fid2,'CalendarType : %f \n', 2); %
   fprintf(fid2,'%%%% Convert calendar to GDD mode if inputs are given in calendar
       \hookrightarrow days (0: No; 1: Yes) %/\n');
   fprintf(fid2,'SwitchGDD : %f \n', 1);%
   fprintf(fid2,'%%%% Planting Date (dd/mm) %%\n');
100 [fprintf(fid2,'PlantingDate : %s \n','01/09'); %
   fprintf(fid2,'%%%% Latest Harvest Date (dd/mm) %%\n');
   fprintf(fid2, 'HarvestDate : %s \n', '30/11'); %
   fprintf(fid2,'%%%% Growing degree/Calendar days from sowing to emergenc \n');
   fprintf(fid2,'Emergence : %f \n', 59);%
105 [fprintf(fid2,'%%%% Growing degree/Calendar days from sowing to \n');
   fprintf(fid2, 'MaxRooting : %f \n', 888); %
   fprintf(fid2,'%%%% Growing degree/Calendar days from sowing to senescence %%\n'
       \leftrightarrow):
    fprintf(fid2,'Senescence : %f \n', 903);8
   fprintf(fid2,'%%%% Growing degree/Calendar days from sowing to maturity %% \n')
       \hookrightarrow;
110 fprintf(fid2, 'Maturity : %f \n', 1298); %
```

```
fprintf(fid2,'%%%% Growing degree/Calendar days from sowing to start of yield
       \hookrightarrow formation %% \n');
    fprintf(fid2,'HIstart : %f \n', 650);%
    fprintf(fid2,'%%%% Duration of flowering in growing degree/calendar days (-999
        \hookrightarrow for non-fruit/grain crops) %% \n');
    fprintf(fid2,'Flowering : %f \n', 233); %
   fprintf(fid2,'%%%% Duration of yield formation in growing degree/calendar days
115
       \leftrightarrow %% \n');
    fprintf(fid2,'YldForm : %f \n', 668);%
    fprintf(fid2,'%%%% Growing degree day calculation method %% \n');
    fprintf(fid2,'GDDmethod : %f \n', 2);%
    fprintf(fid2,'%%%% Base temperature (degC) below which growth does not progress
       \hookrightarrow %% \n');
   fprintf(fid2,'Tbase : %f \n', 9);%
120
    fprintf(fid2,'%%%% Upper temperature (degC) above which crop development no
       \hookrightarrow longer increases \% \n');
    fprintf(fid2,'Tupp : %f \n', 30); %
    fprintf(fid2,'%%% Pollination affected by heat stress (0: No; 1: Yes) %% \n');
    fprintf(fid2,'PolHeatStress : %f \n', 0); %
   fprintf(fid2, '%%%% Maximum air temperature (degC) above which pollination
125
        \hookrightarrow begins to fail \% \ n';
    fprintf(fid2,'Tmax_up : %f \n', 45);%
    fprintf(fid2,'%%%% Maximum air temperature (degC) at which pollination
       \hookrightarrow completely fails \% (n');
    fprintf(fid2,'Tmax_lo : %f \n', 50);%
    fprintf(fid2,'%%%% Pollination affected by cold stress (0: No; 1: Yes) %% \n');
   fprintf(fid2, 'PolColdStress : %f \n', 0); %
130
    fprintf(fid2,'%%% Minimum air temperature (degC) below which pollination
        \hookrightarrow begins to fail \% (n');
    fprintf(fid2,'Tmin_up : %f \n', 5);%
    fprintf(fid2,'%%%% Minimum air temperature (degC) at which pollination
        \hookrightarrow completely fails \% \ n');
    fprintf(fid2,'Tmin_lo : %f \n', 0);%
   fprintf(fid2,'%%%% Biomass production affected by temperature stress (0: No; 1:
135
       \hookrightarrow Yes) %% \n');
    fprintf(fid2,'BioTempStress : %f \n', 1); %
    fprintf(fid2,'%%%% Minimum growing degree days (degC/day) required for full
        \hookrightarrow biomass production %% \n');
    fprintf(fid2,'GDD_up : %f \n', 14); %
    fprintf(fid2, %%%% Growing degree days (degC/day) at which no biomass
        \hookrightarrow production occurs \% n');
140 fprintf(fid2,'GDD_lo : %f \n', 0);%
```

```
fprintf(fid2,'%%%% Shape factor describing the reduction in biomass productig
       \hookrightarrow degree days \% \ n');
    fprintf(fid2,'fshape_b : %f \n', 13.8135);%
    fprintf(fid2,'%%%% Initial percentage of minimum effective rooting depth %% \n'
       \rightarrow):
    fprintf(fid2,'PctZmin : %f \n', 70);%
145 | fprintf(fid2,'%%%% Minimum effective rooting depth (m) %% \n');
    fprintf(fid2, 'Zmin : %f \n', 0.30); %
    fprintf(fid2,'%%%% Maximum rooting depth (m) %% \n');
    fprintf(fid2,'Zmax : %f \n', 1.70);%
    fprintf(fid2,'%%%% Shape factor describing root expansion %% \n');
150 fprintf(fid2,'fshape_r : %f \n', 1.5);%
    fprintf(fid2,'%%%% Shape factor describing the effects of water stress on root
       \hookrightarrow expansion \% (n');
    fprintf(fid2,'fshape_ex : %f \n', -6);%
    fprintf(fid2,'%%%% Maximum root water extraction at top of the root zone (m3/m3
       \hookrightarrow /day) %% \n');
    fprintf(fid2,'SxTopQ : %f \n', 0.019);%
   fprintf(fid2,'%%%% Maximum root water extraction at the bottom of the root zone
155
       \hookrightarrow (m3/m3/day) %% \n');
    fprintf(fid2,'SxBotQ : %f \n', 0.006); %
    fprintf(fid2, '%%% Exponent parameter for adjustment of Kcx once senescence is
       \hookrightarrow triggered %% \n');
    fprintf(fid2, 'a_Tr : %f \n', 1);8
    fprintf(fid2,'%%%% Soil surface area (cm2) covered by an individual seedling %%
       \rightarrow \n'):
160 fprintf(fid2, 'SeedSize : %f \n', 10); %
    fprintf(fid2,'%%%% Number of plants per hectare %% \n');
    fprintf(fid2,'PlantPop : %f \n', 250000);%
    fprintf(fid2,'%%%% Minimum canopy size below which yield formation cannot occur
       \hookrightarrow %% \n');
    fprintf(fid2,'CCmin : %f \n', 0.0225);%
165 [fprintf(fid2, '%%% Maximum canopy cover (fraction of soil cover) %% \n');
    fprintf(fid2,'CCx : %f \n', 0.99); %
    fprintf(fid2,'%%%% Canopy decline coefficient (fraction per day/GDD) %% \n');
    fprintf(fid2,'CDC : %f \n', 0.00881);%
    fprintf(fid2,'%%%% Canopy growth coefficient (fraction per day/GDD) %% \n');
170 fprintf(fid2,'CGC : %f \n', 0.118);%
    fprintf(fid2,'%%%% Crop coefficient when canopy growth is complete but prior to
       \hookrightarrow senescence \% \n');
    fprintf(fid2, 'Kcb : %f \n', 1.10); %
    fprintf(fid2,'%%%% Decline of crop coefficient due to ageing (day) %% \n');
```

```
fprintf(fid2,'fage : %f \n', 0.15);%
   fprintf(fid2,'%%%% Water productivity normalized for ETO and CO2 (g/m2) %% \n')
175
       \hookrightarrow :
    fprintf(fid2,'WP : %f \n', 15); %
    fprintf(fid2,'%%%% Adjustment of water productivity in yield formation stage (
       \hookrightarrow of WP) %% \n');
    fprintf(fid2,'WPy : %f \n', 90); %
    fprintf(fid2,'%%%% Crop co2 sink strength coefficient %% \n');
   fprintf(fid2,'fsink : %f \n', 0.5);%
180
    fprintf(fid2,'%%%% WP co2 adjustment parameter given by Steduto et al. 2007 %%
       \hookrightarrow \langle n' \rangle;
    fprintf(fid2,'bsted : %f \n', 0.000138);%
    fprintf(fid2,'%%% WP co2 adjustment parameter given by FACE experiments %% \n'
       \leftrightarrow);
    fprintf(fid2,'bface : %f \n', 0.001165);%
   fprintf(fid2, '%%% Reference harvest index %% \n');
185
    fprintf(fid2,'HI0 : %f \n', 0.40);%
    fprintf(fid2, '%%%% Initial harvest index %% \n');
    fprintf(fid2,'HIini : %f \n', 0.01);%
    fprintf(fid2,'%%%% Possible increase of harvest index due to water stress
       \hookrightarrow before flowering %% \n');
   fprintf(fid2,'dHI_pre : %f \n', 5);8
190
    fprintf(fid2,'%%%% Coefficient describing positive ed vegetative formation %% \
       \rightarrow n'):
    fprintf(fid2,'a_HI : %f \n', 10);8
    fprintf(fid2,'%%%% Coefficient describing negative impact on harves %% \n');
    fprintf(fid2, 'b_HI : %f \n', 5);%
   fprintf(fid2,'%%%% Maximum allowable increase of harvest index above reference
195
       \hookrightarrow %% \n');
    fprintf(fid2,'dHI0 : %f \n', 10);%
    fprintf(fid2, '%%% Crop Determinancy (0: Indeterminant, 1: Determinant) %% \n')
        \hookrightarrow
    fprintf(fid2,'Determinant : %f \n', 1);%
    fprintf(fid2,'%%%% Excess of potential fruits %% \n');
   fprintf(fid2, 'exc : %f \n', 100); %
200
    fprintf(fid2,'%%%% Percentage of total flowering at which peak flowering occurs
       \hookrightarrow %% \n');
    fprintf(fid2,'MaxFlowPct : %f \n', 33.33);8
    fprintf(fid2,'%%%% Upper soil water depletion threshold for water stress
        \hookrightarrow effects on affect canopy expansion \% \n');
    fprintf(fid2,'p_up1 : %f \n', 0.15);%
```

205fprintf(fid2, '%%%% Upper soil water depletion threshold for water stress  $\hookrightarrow$  effects on canopy stomatal control  $\% \ n'$ ; fprintf(fid2,'p\_up2 : %f \n', 0.15);% fprintf(fid2,'%%%% Upper soil water depletion threshold for water stress  $\hookrightarrow$  effects on canopy senescence %  $\n'$ ); fprintf(fid2,'p\_up3 : %f \n', 0.15);% fprintf(fid2,'%%%% Upper soil water depletion threshold for water stress  $\hookrightarrow$  effects on canopy pollination % n');210 **fprintf(fid2,'p\_up4 : %f \n', 0.15);**% fprintf(fid2,'%%%% Lower soil water depletion threshold for water stress  $\hookrightarrow$  effects on canopy expansion %% \n'); fprintf(fid2,'p\_lo1 : %f \n', 0.65);% fprintf(fid2,'%%%% Lower soil water depletion threshold for water stress  $\hookrightarrow$  effects on canopy stomatal control %% \n'); fprintf(fid2,'p\_lo2 : %f \n', 1);8 215 [fprintf(fid2,'%%%% Lower soil water depletion threshold for water stress  $\hookrightarrow$  effects on canopy senescence % \n'); fprintf(fid2,'p\_lo3 : %f \n', 1);8 fprintf(fid2,'%%%% Lower soil water depletion threshold for water stress  $\hookrightarrow$  effects on canopy pollination  $\% \ n'$ ); fprintf(fid2,'p\_lo4 : %f \n', 1);8 fprintf(fid2, '%%%% Shape factor describing water stress effects on canopy  $\hookrightarrow$  expansion %% \n'); 220 **fprintf**(fid2,'fshape\_w1 : %f \n', 2.5); fprintf(fid2,'%%%% Shape factor describing water stress effects on stomatal  $\hookrightarrow$  control % n');fprintf(fid2,'fshape\_w2 : %f \n', 2.5); fprintf(fid2, '%%%% Shape factor describing water stress effects on canopy  $\hookrightarrow$  senescence % \n'); fprintf(fid2,'fshape\_w3 : %f \n', 2.5); fprintf(fid2, '%%%% Shape factor describing water stress effects on pollination 225 $\hookrightarrow$  %% \n'); fprintf(fid2,'fshape\_w4 : %f \n', 1); fprintf(fid2,'%%%% Adjustment to water stress thresholds depending on daily ETO  $\hookrightarrow$  (0: No, 1: Yes) %% \n'); fprintf(fid2,'ETadj : %f \n', 1); fprintf(fid2,'%%%% Vol below saturation at which stress begins to occur due to  $\hookrightarrow$  deficient aeration %% \n'); 230 **fprintf**(fid2, 'Aer : %f \n', 5); fprintf(fid2,'%%%% Number of days lag before aeration stress affects crop  $\hookrightarrow$  growth %% \n'); fprintf(fid2,'LagAer : %f \n', 3);

```
fprintf(fid2,'%%% Reduction to p_lo3 when early canopy senescence is triggered
       \hookrightarrow %% \n');
    fprintf(fid2,'beta : %f \n', 12);
   fprintf(fid2,'%%%% Proportion of total water storage needed for crop to
235
        \hookrightarrow germinate \% \ \n');
    fprintf(fid2,'GermThr : %f \n', 0.2);
    fclose(fid2);
    end
240
    elseif cropt==2
    %Tomato
    crop={'Tomato'};
    for i=1:1
   fid2 = fopen('Crop.txt','wt');
245
    fprintf(fid2,'%%%% ------ Crop parameters for AquaCropOS ------ %%\n');
    fprintf(fid2,'%%%% Crop Type (1: Leafy vegetable, 2: Root/tuber, 3: Fruit/grain
       \leftrightarrow ) %%\n');
    fprintf(fid2,'CropType : %f\n', 3);%
   fprintf(fid2, '%%%% Calendar Type (1: Calendar days, 2: Growing degree days)\n')
250
       \hookrightarrow
    fprintf(fid2,'CalendarType : %f \n', 2); %
    fprintf(fid2,'%%%% Convert calendar to GDD mode if inputs are given in calendar
       \hookrightarrow days (0: No; 1: Yes) %%\n');
    fprintf(fid2,'SwitchGDD : %f \n', 1); %
    fprintf(fid2,'%%%% Planting Date (dd/mm) %%\n');
   fprintf(fid2,'PlantingDate : %s \n','01/09');
255
    fprintf(fid2,'%%%% Latest Harvest Date (dd/mm) %%\n');
    fprintf(fid2, 'HarvestDate : %s \n', '30/12'); %
    fprintf(fid2, '%%%% Growing degree/Calendar days from sowing to emergenc \n');
    fprintf(fid2,'Emergence : %f \n', 43); %
   fprintf(fid2, '%%%% Growing degree/Calendar days from sowing to \n');
260
    fprintf(fid2, 'MaxRooting : %f \n', 891); %
    fprintf(fid2, '%%%% Growing degree/Calendar days from sowing to senescence %%\n'
       \leftrightarrow);
    fprintf(fid2,'Senescence : %f \n', 1533);%
    fprintf(fid2,'%%%% Growing degree/Calendar days from sowing to maturity %% \n')
        \hookrightarrow
265
   fprintf(fid2,'Maturity : %f \n', 1933);%
    fprintf(fid2,'%%%% Growing degree/Calendar days from sowing to start of yield
       \hookrightarrow formation \% n');
```

	<pre>fprintf(fid2,'HIstart : %f \n', 525);%</pre>
	<pre>fprintf(fid2,'%%%% Duration of flowering in growing degree/calendar days (-999</pre>
	↔ for non-fruit/grain crops) %% \n');
	<pre>fprintf(fid2,'Flowering : %f \n', 750);%</pre>
270	<pre>fprintf(fid2,'%%%% Duration of yield formation in growing degree/calendar days</pre>
	$\leftrightarrow$ %% \n');
	<pre>fprintf(fid2,'YldForm : %f \n', 1050);%</pre>
	<pre>fprintf(fid2,'%%%% Growing degree day calculation method %% \n');</pre>
	<pre>fprintf(fid2,'GDDmethod : %f \n', 2);%</pre>
	<pre>fprintf(fid2,'%%%% Base temperature (degC) below which growth does not progress</pre>
	$\rightarrow$ %% \n');
275	fprintf(fid2,'Tbase : %f \n', 7);%
	<pre>fprintf(fid2,'%%%% Upper temperature (degC) above which crop development no</pre>
	→ longer increases %% \n');
	fprintf(fid2,'Tupp : %f \n', 28); %
	<pre>fprintf(fid2,'%%%% Pollination affected by heat stress (0: No; 1: Yes) %% \n');</pre>
	<pre>fprintf(fid2,'PolHeatStress : %f \n', 1);%</pre>
280	<pre>fprintf(fid2,'%%%% Maximum air temperature (degC) above which pollination</pre>
	$\hookrightarrow$ begins to fail %% \n');
	<pre>fprintf(fid2,'Tmax_up : %f \n', 40);%</pre>
	<pre>fprintf(fid2,'%%%% Maximum air temperature (degC) at which pollination</pre>
	$\hookrightarrow$ completely fails %% \n');
	<b>fprintf(fid2,</b> 'Tmax_lo : %f \n', 45);%
	<pre>fprintf(fid2,'%%%% Pollination affected by cold stress (0: No; 1: Yes) %% \n');</pre>
285	<pre>fprintf(fid2,'PolColdStress : %f \n', 1);%</pre>
	<pre>fprintf(fid2,'%%%% Minimum air temperature (degC) below which pollination</pre>
	$\hookrightarrow$ begins to fail %% \n');
	<pre>fprintf(fid2,'Tmin_up : %f \n', 10);%</pre>
	<pre>fprintf(fid2,'%%%% Minimum air temperature (degC) at which pollination</pre>
	$\hookrightarrow$ completely fails %% \n');
	<pre>fprintf(fid2,'Tmin_lo : %f \n', 5);%</pre>
290	<pre>fprintf(fid2,'%%%% Biomass production affected by temperature stress (0: No; 1:</pre>
	$\hookrightarrow$ Yes) %% \n');
	<pre>fprintf(fid2,'BioTempStress : %f \n', 0);%</pre>
	<pre>fprintf(fid2,'%%%% Minimum growing degree days (degC/day) required for full</pre>
	$\hookrightarrow$ biomass production %% \n');
	<b>fprintf(fid2,</b> 'GDD_up : %f \n', -999); %
	<pre>fprintf(fid2,'%%%% Growing degree days (degC/day) at which no biomass</pre>
	$\hookrightarrow$ production occurs %% \n');
295	fprintf(fid2,'GDD_lo : %f \n', -999); %
	<pre>fprintf(fid2,'%%%% Shape factor describing the reduction in biomass productig</pre>
	↔ degree days %% \n');

```
fprintf(fid2,'fshape_b : %f \n', 13.8135);%
    fprintf(fid2,'%%%% Initial percentage of minimum effective rooting depth %% \n'
       \leftrightarrow);
    fprintf(fid2, 'PctZmin : %f \n', 70); %
   fprintf(fid2,'%%%% Minimum effective rooting depth (m) %% \n');
300
    fprintf(fid2,'Zmin : %f \n', 0.30);%
    fprintf(fid2,'%%%% Maximum rooting depth (m) %% \n');
    fprintf(fid2,'Zmax : %f \n', 1);%
    fprintf(fid2, '%%%% Shape factor describing root expansion %% \n');
   fprintf(fid2,'fshape_r : %f \n', 1.5);%
305
    fprintf(fid2,'%%%% Shape factor describing the effects of water stress on root
       \hookrightarrow expansion %% \n');
    fprintf(fid2,'fshape_ex : %f \n', -6);%
    fprintf(fid2,'%%% Maximum root water extraction at top of the root zone (m3/m3
       \hookrightarrow /day) %% \n');
    fprintf(fid2, 'SxTopQ : %f \n', 0.024); %
   fprintf(fid2, '%%%% Maximum root water extraction at the bottom of the root zone
310
       \hookrightarrow (m3/m3/day) %% \n');
    fprintf(fid2,'SxBotQ : %f \n', 0.006); %
    fprintf(fid2,'%%%% Exponent parameter for adjustment of Kcx once senescence is
       \hookrightarrow triggered %% \n');
    fprintf(fid2,'a_Tr : %f \n', 1);%
    fprintf(fid2,'%%%% Soil surface area (cm2) covered by an individual seedling %%
       \rightarrow \ \ );
315 fprintf(fid2,'SeedSize : %f \n', 20); %
    fprintf(fid2,'%%%% Number of plants per hectare %% \n');
    fprintf(fid2, 'PlantPop : %f \n', 33333); %
    fprintf(fid2,'%%%% Minimum canopy size below which yield formation cannot occur
       \rightarrow %% \n');
    fprintf(fid2,'CCmin : %f \n', 0.0067);%
   fprintf(fid2,'%%%% Maximum canopy cover (fraction of soil cover) %% \n');
320
    fprintf(fid2,'CCx : %f \n', 0.75);%
    fprintf(fid2,'%%%% Canopy decline coefficient (fraction per day/GDD) %% \n');
    fprintf(fid2,'CDC : %f \n', 0.004); %
    fprintf(fid2,'%%%% Canopy growth coefficient (fraction per day/GDD) %% \n');
   fprintf(fid2,'CGC : %f \n', 0.007504); %
325
    fprintf(fid2,'%%%% Crop coefficient when canopy growth is complete but prior to
       \hookrightarrow senescence \% \n');
    fprintf(fid2,'Kcb : %f \n', 1.1); %
    fprintf(fid2,'%%%% Decline of crop coefficient due to ageing (day) %% \n');
    fprintf(fid2,'fage : %f \n', 0.15);%
```

330	<pre>fprintf(fid2,'%%%% Water productivity normalized for ETO and CO2 (g/m2) %% \n')</pre>
	$\leftrightarrow$ ;
	fprintf(fid2,'WP : %f \n', 18);%
	<pre>fprintf(fid2,'%%%% Adjustment of water productivity in yield formation stage (</pre>
	$\hookrightarrow$ of WP) %% \n');
	<b>fprintf(fid2,</b> 'WPy : %f \n', 100);%
	<pre>fprintf(fid2,'%%%% Crop co2 sink strength coefficient %% \n');</pre>
335	<pre>fprintf(fid2,'fsink : %f \n', 0.5);%</pre>
	<pre>fprintf(fid2,'%%%% WP co2 adjustment parameter given by Steduto et al. 2007 %%</pre>
	$\rightarrow n'$ );
	<pre>fprintf(fid2,'bsted : %f \n', 0.000138);%</pre>
	<pre>fprintf(fid2,'%%%% WP co2 adjustment parameter given by FACE experiments %% \n'</pre>
	$\leftrightarrow$ );
	<pre>fprintf(fid2,'bface : %f \n', 0.001165);%</pre>
340	<pre>fprintf(fid2,'%%%% Reference harvest index %% \n');</pre>
	<pre>fprintf(fid2,'HI0 : %f \n', 0.63);%</pre>
	<pre>fprintf(fid2,'%%%% Initial harvest index %% \n');</pre>
	<b>fprintf(fid2,</b> 'HIini : %f \n', 0.01); %
	<pre>fprintf(fid2,'%%%% Possible increase of harvest index due to water stress</pre>
	$\hookrightarrow$ before flowering %% \n');
345	<pre>fprintf(fid2,'dHI_pre : %f \n', 0);%</pre>
	<pre>fprintf(fid2,'%%%% Coefficient describing positive ed vegetative formation %% \</pre>
	$\leftrightarrow$ n');
	<pre>fprintf(fid2, 'a_HI : %f \n', -9);%</pre>
	<pre>fprintf(fid2, '%%%% Coefficient describing negative impact on harves %% \n');</pre>
	fprintf(fid2,'b_HI : %f \n', 3); %
350	<pre>fprintf(fid2, '%%%% Maximum allowable increase of harvest index above reference</pre>
	$\leftrightarrow$ %% \n');
	<pre>fprintf(fid2,'dHIO : %f \n', 15);%</pre>
	<pre>fprintf(fid2,'%%%% Crop Determinancy (0: Indeterminant, 1: Determinant) %% \n')</pre>
	$\rightarrow$ ;
	<pre>fprintf(fid2, 'Determinant : %f \n', 1); %</pre>
	<pre>fprintf(fid2,'%%%% Excess of potential fruits %% \n');</pre>
355	<pre>fprintf(fid2, 'exc : %f \n', 100);%</pre>
	<pre>fprintf(fid2,'%%%% Percentage of total flowering at which peak flowering occurs</pre>
	$\leftrightarrow$ %% \n');
	<pre>fprintf(fid2, 'MaxFlowPct : %f \n', 33.33);%</pre>
	<pre>fprintf(fid2,'%%%% Upper soil water depletion threshold for water stress</pre>
	$\hookrightarrow$ effects on affect canopy expansion $\% \n'$ ;
260	<pre>fprintf(fid2, 'p_up1 : %f \n', 0.15);% fprintf(fid2 ''''''' Upper soil upter depletion threshold for upter stress</pre>
360	<pre>fprintf(fid2, '%%%% Upper soil water depletion threshold for water stress → effects on canopy stomatal control %% \n');</pre>
	, criccop on camply bromatar control /0/0 /m /,

```
fprintf(fid2,'p_up2 : %f \n', 0.5);%
    fprintf(fid2,'%%%% Upper soil water depletion threshold for water stress
        \hookrightarrow effects on canopy senescence \% \ n');
    fprintf(fid2,'p_up3 : %f \n', 0.7);%
    fprintf(fid2,'%%%% Upper soil water depletion threshold for water stress
        \hookrightarrow effects on canopy pollination \% (n');
   fprintf(fid2,'p_up4 : %f \n', 0.92);%
365
    fprintf(fid2,'%%%% Lower soil water depletion threshold for water stress
        \hookrightarrow effects on canopy expansion \% (n');
    fprintf(fid2,'p_lo1 : %f \n', 0.55);%
    fprintf(fid2,'%%%% Lower soil water depletion threshold for water stress
        \hookrightarrow effects on canopy stomatal control %% \n');
    fprintf(fid2,'p_lo2 : %f \n', 1);8
   fprintf(fid2, '%%%% Lower soil water depletion threshold for water stress
370
        \hookrightarrow effects on canopy senescence %% \n');
    fprintf(fid2,'p_lo3 : %f \n', 1);%
    fprintf(fid2,'%%%% Lower soil water depletion threshold for water stress
        \hookrightarrow effects on canopy pollination \% \ n');
    fprintf(fid2,'p_lo4 : %f \n', 1); %
    fprintf(fid2, '%%% Shape factor describing water stress effects on canopy
        \hookrightarrow expansion %% \n');
   fprintf(fid2,'fshape_w1 : %f \n', 3);
375
    fprintf(fid2,'%%%% Shape factor describing water stress effects on stomatal
       \hookrightarrow control \% n');
    fprintf(fid2,'fshape_w2 : %f \n', 3);
    fprintf(fid2, '%%%% Shape factor describing water stress effects on canopy
        \hookrightarrow senescence \% \n');
    fprintf(fid2,'fshape_w3 : %f \n', 3);
    fprintf(fid2,'%%%% Shape factor describing water stress effects on pollination
380
        \hookrightarrow %% \n');
    fprintf(fid2,'fshape_w4 : %f \n', 1);
    fprintf(fid2,'%%% Adjustment to water stress thresholds depending on daily ETO
        \hookrightarrow (0: No, 1: Yes) \% \n');
    fprintf(fid2,'ETadj : %f \n', 1);
    fprintf(fid2,'%%%% Vol below saturation at which stress begins to occur due to
        \hookrightarrow deficient aeration \% n');
   fprintf(fid2,'Aer : %f \n', 5);
385
    fprintf(fid2,'%%%% Number of days lag before aeration stress affects crop
        \hookrightarrow growth %% \n');
    fprintf(fid2,'LagAer : %f \n', 3);
    fprintf(fid2,'%%% Reduction to p_lo3 when early canopy senescence is triggered
        \hookrightarrow %% \n');
```

```
fprintf(fid2,'beta : %f \n', 12);
390 [fprintf(fid2,'%%%% Proportion of total water storage needed for crop to
       \hookrightarrow germinate \% (n');
    fprintf(fid2,'GermThr : %f \n', 0.2);
    fclose(fid2);
    end
395
    elseif cropt==3
    %Sugar Cane
    crop={'Maize'};
    for i=1:1
400 [fid2 = fopen('Crop.txt','wt');
    fprintf(fid2,'%%%% ------ Crop parameters for AquaCropOS ----- %%\n');
    fprintf(fid2,'%%%% Crop Type (1: Leafy vegetable, 2: Root/tuber, 3: Fruit/grain
       \rightarrow ) %%\n');
    fprintf(fid2,'CropType : %f\n', 1);%
   fprintf(fid2, '%%%% Calendar Type (1: Calendar days, 2: Growing degree days)\n')
405
       \hookrightarrow:
    fprintf(fid2,'CalendarType : %f \n', 1); %
    fprintf(fid2,'%%%% Convert calendar to GDD mode if inputs are given in calendar
       \hookrightarrow days (0: No; 1: Yes) %/\n');
    fprintf(fid2,'SwitchGDD : %f \n', 0); %
    fprintf(fid2,'%%%% Planting Date (dd/mm) %%\n');
410 [fprintf(fid2,'PlantingDate : %s \n','01/09'); 8
    fprintf(fid2,'%%%% Latest Harvest Date (dd/mm) %%\n');
    fprintf(fid2, 'HarvestDate : %s \n', '30/08'); %
    fprintf(fid2, '%%%% Growing degree/Calendar days from sowing to emergenc \n');
    fprintf(fid2,'Emergence : %f \n', 7);%
415 fprintf(fid2, '%%%% Growing degree/Calendar days from sowing to \n');
    fprintf(fid2, 'MaxRooting : %f \n', 60); %
    fprintf(fid2, '%%% Growing degree/Calendar days from sowing to senescence %%\n'
       \rightarrow);
    fprintf(fid2,'Senescence : %f \n', 330); %
    fprintf(fid2,'%%%% Growing degree/Calendar days from sowing to maturity %% \n')
       \hookrightarrow:
420 fprintf(fid2, 'Maturity : %f \n', 365); %
    fprintf(fid2,'%%%% Growing degree/Calendar days from sowing to start of yield
       \hookrightarrow formation %% \n');
    fprintf(fid2,'HIstart : %f \n', 0);
```

```
fprintf(fid2, '%%% Duration of flowering in growing degree/calendar days (-999
        \hookrightarrow for non-fruit/grain crops) %% \n');
    fprintf(fid2,'Flowering : %f \n', -999);%
   fprintf(fid2,'%%%% Duration of yield formation in growing degree/calendar days
425
        \hookrightarrow %% \n');
    fprintf(fid2,'YldForm : %f \n', 73);%
    fprintf(fid2,'%%%% Growing degree day calculation method %% \n');
    fprintf(fid2,'GDDmethod : %f \n', 2);%
    fprintf(fid2,'%%%% Base temperature (degC) below which growth does not progress
        \hookrightarrow %% \n');
   fprintf(fid2,'Tbase : %f \n', 9);%
430
    fprintf(fid2,'%%%% Upper temperature (degC) above which crop development no
        \hookrightarrow longer increases \% n');
    fprintf(fid2,'Tupp : %f \n', 40); %
    fprintf(fid2,'%%%% Pollination affected by heat stress (0: No; 1: Yes) %% \n');
    fprintf(fid2,'PolHeatStress : %f \n', 0); %
   fprintf(fid2,'%%%% Maximum air temperature (degC) above which pollination
435
        \hookrightarrow begins to fail \% \ n');
    fprintf(fid2,'Tmax_up : %f \n', -999);%
    fprintf(fid2,'%%% Maximum air temperature (degC) at which pollination
        \hookrightarrow completely fails \% n');
    fprintf(fid2,'Tmax_lo : %f \n', -999);%
    fprintf(fid2,'%%%% Pollination affected by cold stress (0: No; 1: Yes) %% \n');
440 fprintf(fid2,'PolColdStress : %f \n', 0); %
    fprintf(fid2,'%%%% Minimum air temperature (degC) below which pollination
        \hookrightarrow begins to fail \% \ n';
    fprintf(fid2, 'Tmin_up : %f \n', -999); %
    fprintf(fid2,'%%%% Minimum air temperature (degC) at which pollination
        \hookrightarrow completely fails \% (n');
    fprintf(fid2,'Tmin_lo : %f \n', -999);%
   fprintf(fid2, '%%% Biomass production affected by temperature stress (0: No; 1:
445
        \hookrightarrow Yes) %% \n');
    fprintf(fid2, 'BioTempStress : %f \n', 1); %
    fprintf(fid2,'%%%% Minimum growing degree days (degC/day) required for full
        \hookrightarrow biomass production \% \n');
    fprintf(fid2,'GDD_up : %f \n', 12); %
    fprintf(fid2, '%%%% Growing degree days (degC/day) at which no biomass
        \hookrightarrow production occurs %% \n');
   fprintf(fid2,'GDD_lo : %f \n', 0); %
450
    fprintf(fid2,'%%%% Shape factor describing the reduction in biomass productig
        \hookrightarrow degree days \% (n');
    fprintf(fid2,'fshape_b : %f \n', 13.8135);%
```

	<pre>fprintf(fid2,'%%%% Initial percentage of minimum effective rooting depth %% \n'</pre>
	$\rightarrow$ );
	<pre>fprintf(fid2,'PctZmin : %f \n', 70);%</pre>
455	<pre>fprintf(fid2, '%%%% Minimum effective rooting depth (m) %% \n');</pre>
400	<pre>fprintf(fid2, 'Zmin : %f \n', 0.30);%</pre>
	<pre>fprintf(fid2, '%%% Maximum rooting depth (m) %% \n');</pre>
	<pre>fprintf(fid2, 'Zmax : %f \n', 1.80);%</pre>
	<pre>fprintf(fid2, '%%%% Shape factor describing root expansion %% \n');</pre>
460	<pre>fprintf(fid2, 'fshape_r : %f \n', 1.3);%</pre>
400	<pre>fprintf(fid2, '%%%% Shape factor describing the effects of water stress on root</pre>
	<pre>→ expansion %% \n');</pre>
	<pre>fprintf(fid2, 'fshape_ex : %f \n', -6);%</pre>
	fprintf(fid2, '%%%% Maximum root water extraction at top of the root zone (m3/m3)
	$\rightarrow$ /day) %% \n');
	<pre>fprintf(fid2,'SxTopQ : %f \n', 0.013);%</pre>
465	<pre>fprintf(fid2, '%%%% Maximum root water extraction at the bottom of the root zone</pre>
100	$\rightarrow$ (m3/m3/day) %% \n');
	<pre>fprintf(fid2, 'SxBotQ : %f \n', 0.003);%</pre>
	<pre>fprintf(fid2, '%%%% Exponent parameter for adjustment of Kcx once senescence is</pre>
	<pre> → triggered %% \n'); </pre>
	<b>fprintf(fid2</b> , 'a_Tr : %f \n', 1);%
	<pre>fprintf(fid2,'%%%% Soil surface area (cm2) covered by an individual seedling %%</pre>
	$\rightarrow (n');$
470	<pre>fprintf(fid2,'SeedSize : %f \n', 6.5); %</pre>
	<pre>fprintf(fid2,'%%%% Number of plants per hectare %% \n');</pre>
	fprintf(fid2,'PlantPop : %f \n', 140000);%
	fprintf(fid2,'%%%% Minimum canopy size below which yield formation cannot occur
	$\rightarrow$ %% \n');
	fprintf(fid2,'CCmin : %f \n', 0.0091);%
475	<pre>fprintf(fid2,'%%%% Maximum canopy cover (fraction of soil cover) %% \n');</pre>
	<b>fprintf</b> (fid2,'CCx : %f \n', 0.95);%
	<pre>fprintf(fid2,'%%%% Canopy decline coefficient (fraction per day/GDD) %% \n');</pre>
	<b>fprintf(fid2,</b> 'CDC : %f \n', 0.076); %
	<pre>fprintf(fid2,'%%%% Canopy growth coefficient (fraction per day/GDD) %% \n');</pre>
480	<pre>fprintf(fid2,'CGC : %f \n', 0.125);%</pre>
	<pre>fprintf(fid2,'%%%% Crop coefficient when canopy growth is complete but prior to</pre>
	$\hookrightarrow$ senescence %% \n');
	<b>fprintf(fid2</b> , 'Kcb : %f \n', 1.10); %
	<pre>fprintf(fid2,'%%%% Decline of crop coefficient due to ageing (day) %% \n');</pre>
	<pre>fprintf(fid2,'fage : %f \n', 0.15);%</pre>
485	<pre>fprintf(fid2,'%%%% Water productivity normalized for ETO and CO2 (g/m2) %% \n')</pre>
	$\hookrightarrow$ ;

```
fprintf(fid2,'WP : %f \n', 30); %
    fprintf(fid2, '%%%% Adjustment of water productivity in yield formation stage (
       \hookrightarrow of WP) %% \n');
    fprintf(fid2,'WPy : %f \n', 100); %
    fprintf(fid2, '%%% Crop co2 sink strength coefficient %% \n');
   fprintf(fid2,'fsink : %f \n', 0.5);%
490
    fprintf(fid2,'%%%% WP co2 adjustment parameter given by Steduto et al. 2007 %%
       \leftrightarrow \langle n' \rangle;
    fprintf(fid2,'bsted : %f \n', 0.000138);%
    fprintf(fid2,'%%%% WP co2 adjustment parameter given by FACE experiments %% \n'
       \leftrightarrow);
    fprintf(fid2,'bface : %f \n', 0.001165);%
   fprintf(fid2, '%%%% Reference harvest index %% \n');
495
    fprintf(fid2,'HIO : %f \n', 0.35); %
    fprintf(fid2,'%%%% Initial harvest index %% \n');
    fprintf(fid2,'HIini : %f \n', 0.01);%
    fprintf(fid2,'%%%% Possible increase of harvest index due to water stress
       \hookrightarrow before flowering %% \n');
   fprintf(fid2,'dHI_pre : %f \n', 0);%
500
    fprintf(fid2,'%%%% Coefficient describing positive ed vegetative formation %% \
       \rightarrow n');
    fprintf(fid2, 'a_HI : %f \n', -999);%
    fprintf(fid2,'%%%% Coefficient describing negative impact on harves %% \n');
    fprintf(fid2,'b_HI : %f \n', -999);%
   fprintf(fid2,'%%%% Maximum allowable increase of harvest index above reference
505
       \leftrightarrow %% \n');
    fprintf(fid2,'dHI0 : %f \n', -999);%
    fprintf(fid2,'%%%% Crop Determinancy (0: Indeterminant, 1: Determinant) %% \n')
       \hookrightarrow :
    fprintf(fid2, 'Determinant : %f \n', 0); %
    fprintf(fid2,'%%% Excess of potential fruits %% \n');
510 fprintf(fid2, 'exc : %f \n', 0); %
    fprintf(fid2, '%%% Percentage of total flowering at which peak flowering occurs
       \rightarrow %% \n');
    fprintf(fid2,'MaxFlowPct : %f \n', 33.33); %
    fprintf(fid2,'%%%% Upper soil water depletion threshold for water stress
        \hookrightarrow effects on affect canopy expansion \% \n';
    fprintf(fid2,'p_up1 : %f \n', 0.25);%
   fprintf(fid2, '%%%% Upper soil water depletion threshold for water stress
515
        \hookrightarrow effects on canopy stomatal control %% \n');
    fprintf(fid2,'p_up2 : %f \n', 0.5);%
```

fprintf(fid2,'%%%% Upper soil water depletion threshold for water stress  $\hookrightarrow$  effects on canopy senescence %  $\n'$ ); fprintf(fid2,'p\_up3 : %f \n', 0.6);% fprintf(fid2,'%%%% Upper soil water depletion threshold for water stress  $\hookrightarrow$  effects on canopy pollination % n');fprintf(fid2,'p\_up4 : %f \n', 1);% 520 fprintf(fid2,'%%%% Lower soil water depletion threshold for water stress  $\hookrightarrow$  effects on canopy expansion % n');fprintf(fid2,'p\_lo1 : %f \n', 0.55);% fprintf(fid2,'%%%% Lower soil water depletion threshold for water stress  $\hookrightarrow$  effects on canopy stomatal control %% \n'); fprintf(fid2,'p\_lo2 : %f \n', 1);% 525 [fprintf(fid2,'%%%% Lower soil water depletion threshold for water stress  $\hookrightarrow$  effects on canopy senescence %  $\n'$ ); fprintf(fid2,'p\_lo3 : %f \n', 1);% fprintf(fid2,'%%%% Lower soil water depletion threshold for water stress  $\hookrightarrow$  effects on canopy pollination  $\% \ n'$ ); fprintf(fid2,'p\_lo4 : %f \n', 1);8 fprintf(fid2, '%%%% Shape factor describing water stress effects on canopy  $\hookrightarrow$  expansion % (n');530 **fprintf**(fid2, 'fshape\_w1 : %f \n', 3); fprintf(fid2,'%%%% Shape factor describing water stress effects on stomatal  $\hookrightarrow$  control %% \n'); fprintf(fid2,'fshape\_w2 : %f \n', 3); fprintf(fid2,'%%%% Shape factor describing water stress effects on canopy  $\hookrightarrow$  senescence % \n'); fprintf(fid2,'fshape\_w3 : %f \n', 3); 535 [fprintf(fid2,'%%%% Shape factor describing water stress effects on pollination  $\hookrightarrow$  %% \n'); fprintf(fid2,'fshape\_w4 : %f \n', 1); fprintf(fid2,'%%% Adjustment to water stress thresholds depending on daily ETO  $\hookrightarrow$  (0: No, 1: Yes) %% \n'); fprintf(fid2,'ETadj : %f \n', 1); fprintf(fid2,'%%%% Vol below saturation at which stress begins to occur due to  $\hookrightarrow$  deficient aeration % (n');540 **fprintf**(fid2, 'Aer : %f \n', 5); fprintf(fid2,'%%%% Number of days lag before aeration stress affects crop  $\hookrightarrow$  growth %% \n'); fprintf(fid2,'LagAer : %f \n', 3); fprintf(fid2,'%%%% Reduction to p\_lo3 when early canopy senescence is triggered  $\leftrightarrow$  %% \n'); fprintf(fid2,'beta : %f \n', 12);

```
fprintf(fid2, '%%%% Proportion of total water storage needed for crop to
545
       \hookrightarrow germinate %% \n');
    fprintf(fid2,'GermThr : %f \n', 0.2);
    fclose(fid2);
    end
550
    elseif cropt==4
    %Potato
    crop={'Potato'};
    for i=1:1
   fid2 = fopen('Crop.txt','wt');
555
    fprintf(fid2,'%%% ------ Crop parameters for AquaCropOS ----- %%\n');
    fprintf(fid2,'%%%% Crop Type (1: Leafy vegetable, 2: Root/tuber, 3: Fruit/grain
       \leftrightarrow ) %%\n');
    fprintf(fid2,'CropType : %f\n', 2);%
   fprintf(fid2, '%%%% Calendar Type (1: Calendar days, 2: Growing degree days)\n')
560
       \hookrightarrow :
    fprintf(fid2, 'CalendarType : %f \n', 2); %
    fprintf(fid2,'%%%% Convert calendar to GDD mode if inputs are given in calendar
       \hookrightarrow days (0: No; 1: Yes) %/\n');
    fprintf(fid2,'SwitchGDD : %f \n', 1); %
    fprintf(fid2,'%%%% Planting Date (dd/mm) %%\n');
   fprintf(fid2,'PlantingDate : %s \n','01/09');8
565
    fprintf(fid2,'%%%% Latest Harvest Date (dd/mm) %%\n');
    fprintf(fid2, 'HarvestDate : %s \n', '30/11'); %
    fprintf(fid2,'%%%% Growing degree/Calendar days from sowing to emergenc \n');
    fprintf(fid2,'Emergence : %f \n', 200);%
570 [fprintf(fid2,'%%%% Growing degree/Calendar days from sowing to \n');
    fprintf(fid2, 'MaxRooting : %f \n', 1079); %
    fprintf(fid2,'%%%% Growing degree/Calendar days from sowing to senescence %%\n'
       \leftrightarrow):
    fprintf(fid2,'Senescence : %f \n', 984); %
    fprintf(fid2,'%%%% Growing degree/Calendar days from sowing to maturity %% \n')
        \hookrightarrow :
   fprintf(fid2,'Maturity : %f \n', 1276); %
575
    fprintf(fid2,'%%%% Growing degree/Calendar days from sowing to start of yield
        \hookrightarrow formation \% (n');
    fprintf(fid2,'HIstart : %f \n', 550);%
    fprintf(fid2,'%%%% Duration of flowering in growing degree/calendar days (-999
       \hookrightarrow for non-fruit/grain crops) %% \n');
```

fprintf(fid2,'Flowering : %f \n', 0);% 580 [fprintf(fid2,'%%%% Duration of yield formation in growing degree/calendar days  $\hookrightarrow$  %% \n'); fprintf(fid2,'YldForm : %f \n', 700);% fprintf(fid2,'%%%% Growing degree day calculation method %% \n'); fprintf(fid2,'GDDmethod : %f \n', 2);% fprintf(fid2,'%%%% Base temperature (degC) below which growth does not progress  $\hookrightarrow$  %% \n'); 585 **fprintf(fid2,**'Tbase : %f \n', 2); % fprintf(fid2,'%%%% Upper temperature (degC) above which crop development no  $\hookrightarrow$  longer increases % \n'); fprintf(fid2,'Tupp : %f \n', 40); % fprintf(fid2,'%%%% Pollination affected by heat stress (0: No; 1: Yes) %% \n'); fprintf(fid2,'PolHeatStress : %f \n', 0); % 590fprintf(fid2,'%%%% Maximum air temperature (degC) above which pollination  $\hookrightarrow$  begins to fail % (n');fprintf(fid2,'Tmax\_up : %f \n', -999); % fprintf(fid2,'%%% Maximum air temperature (degC) at which pollination  $\hookrightarrow$  completely fails  $\% \ n'$ ); fprintf(fid2,'Tmax\_lo : %f \n', -999);% fprintf(fid2,'%%%% Pollination affected by cold stress (0: No; 1: Yes) %% \n'); 595 **fprintf(fid2,**'PolColdStress : %f \n', 0); % fprintf(fid2,'%%%% Minimum air temperature (degC) below which pollination  $\hookrightarrow$  begins to fail  $\% \ n'$ ); fprintf(fid2,'Tmin\_up : %f \n', -999);% fprintf(fid2,'%%%% Minimum air temperature (degC) at which pollination  $\hookrightarrow$  completely fails % n');fprintf(fid2,'Tmin\_lo : %f \n', -999);% fprintf(fid2, '%%%% Biomass production affected by temperature stress (0: No; 1: 600  $\hookrightarrow$  Yes) %% \n'); fprintf(fid2, 'BioTempStress : %f \n', 1); % fprintf(fid2,'%%%% Minimum growing degree days (degC/day) required for full  $\hookrightarrow$  biomass production % n');**fprintf**(fid2,'GDD\_up : %f \n', 7);% fprintf(fid2, '%%%% Growing degree days (degC/day) at which no biomass  $\hookrightarrow$  production occurs %% \n'); 605 **[fprintf(fid2,'GDD\_lo : %f \n', 0);** fprintf(fid2,'%%%% Shape factor describing the reduction in biomass productig  $\hookrightarrow$  degree days % (n');fprintf(fid2,'fshape\_b : %f \n', 13.8135);% fprintf(fid2,'%%%% Initial percentage of minimum effective rooting depth %% \n'  $\rightarrow$ );

```
fprintf(fid2,'PctZmin : %f \n', 70);%
   fprintf(fid2, '%%%% Minimum effective rooting depth (m) %% \n');
610
    fprintf(fid2, 'Zmin : %f \n', 0.30); %
    fprintf(fid2,'%%%% Maximum rooting depth (m) %% \n');
    fprintf(fid2,'Zmax : %f \n', 1.5);%
    fprintf(fid2,'%%%% Shape factor describing root expansion %% \n');
615 fprintf(fid2,'fshape_r : %f \n', 1.5);%
    fprintf(fid2,'%%%% Shape factor describing the effects of water stress on root
       \hookrightarrow expansion %% \n');
    fprintf(fid2,'fshape_ex : %f \n', -6);%
    fprintf(fid2,'%%%% Maximum root water extraction at top of the root zone (m3/m3
       \hookrightarrow /day) %% \n');
    fprintf(fid2,'SxTopQ : %f \n', 0.016); %
   fprintf(fid2,'%%%% Maximum root water extraction at the bottom of the root zone
620
       \hookrightarrow (m3/m3/day) %% \n');
    fprintf(fid2,'SxBotQ : %f \n', 0.004);%
    fprintf(fid2, '%%% Exponent parameter for adjustment of Kcx once senescence is
       \hookrightarrow triggered %% \n');
    fprintf(fid2, 'a_Tr : %f \n', 1); %
    fprintf(fid2,'%%%% Soil surface area (cm2) covered by an individual seedling %%
       \rightarrow \langle n' \rangle;
   fprintf(fid2,'SeedSize : %f \n', 15); %
625
    fprintf(fid2,'%%%% Number of plants per hectare %% \n');
    fprintf(fid2, 'PlantPop : %f \n', 40000); %
    fprintf(fid2,'%%%% Minimum canopy size below which yield formation cannot occur
       \leftrightarrow %% \n');
    fprintf(fid2,'CCmin : %f \n', 0.006);%
   fprintf(fid2,'%%%% Maximum canopy cover (fraction of soil cover) %% \n');
630
    fprintf(fid2,'CCx : %f \n', 0.92);%
    fprintf(fid2,'%%%% Canopy decline coefficient (fraction per day/GDD) %% \n');
    fprintf(fid2, 'CDC : %f \n', 0.002);%
    fprintf(fid2,'%%%% Canopy growth coefficient (fraction per day/GDD) %% \n');
   fprintf(fid2, 'CGC : %f \n', 0.01615); %
635
    fprintf(fid2,'%%%% Crop coefficient when canopy growth is complete but prior to
       \hookrightarrow senescence \% \n');
    fprintf(fid2, 'Kcb : %f \n', 1.1); %
    fprintf(fid2,'%%%% Decline of crop coefficient due to ageing (day) %% \n');
    fprintf(fid2,'fage : %f \n', 0.15);%
   fprintf(fid2, '%%% Water productivity normalized for ETO and CO2 (g/m2) %% \n')
640
        \hookrightarrow ;
    fprintf(fid2,'WP : %f \n', 18); %
```

fprintf(fid2,'%%%% Adjustment of water productivity in yield formation stage (  $\hookrightarrow$  of WP) %% \n'); fprintf(fid2,'WPy : %f \n', 100);% fprintf(fid2,'%%%% Crop co2 sink strength coefficient %% \n'); 645 **fprintf(fid2,'fsink** : %f \n', 0.5); % fprintf(fid2,'%%% WP co2 adjustment parameter given by Steduto et al. 2007 %%  $\rightarrow \n'$ ): fprintf(fid2,'bsted : %f \n', 0.000138);% fprintf(fid2,'%%%% WP co2 adjustment parameter given by FACE experiments %% \n'  $\rightarrow$ ); fprintf(fid2,'bface : %f \n', 0.001165);% 650 **fprintf(fid2,'%%%%** Reference harvest index %% \n'); fprintf(fid2,'HI0 : %f \n', 0.75);% fprintf(fid2,'%%%% Initial harvest index %% \n'); fprintf(fid2,'HIini : %f \n', 0.01);% fprintf(fid2, '%%% Possible increase of harvest index due to water stress  $\hookrightarrow$  before flowering %% \n'); 655 **fprintf(fid2,'dHI\_pre : %f \n', 2);**% fprintf(fid2,'%%%% Coefficient describing positive ed vegetative formation %% \  $\rightarrow$  n'); **fprintf**(fid2, 'a\_HI : %f \n', -999); % fprintf(fid2,'%%%% Coefficient describing negative impact on harves %% \n'); **fprintf**(fid2, 'b\_HI : %f \n', 10); % 660 [fprintf(fid2,'%%%% Maximum allowable increase of harvest index above reference  $\hookrightarrow$  %% \n'); fprintf(fid2,'dHI0 : %f \n', 5);% fprintf(fid2,'%%%% Crop Determinancy (0: Indeterminant, 1: Determinant) %% \n')  $\hookrightarrow$  ; fprintf(fid2, 'Determinant : %f \n', 0); % fprintf(fid2,'%%%% Excess of potential fruits %% \n'); 665 **fprintf**(fid2, 'exc : %f \n', -999); % fprintf(fid2,'%%%% Percentage of total flowering at which peak flowering occurs  $\hookrightarrow$  %% \n'); fprintf(fid2,'MaxFlowPct : %f \n', 33.33); % fprintf(fid2,'%%%% Upper soil water depletion threshold for water stress  $\hookrightarrow$  effects on affect canopy expansion  $\% \n'$ ; fprintf(fid2,'p\_up1 : %f \n', 0.2);% 670 [fprintf(fid2,'%%%% Upper soil water depletion threshold for water stress  $\hookrightarrow$  effects on canopy stomatal control % \n'); fprintf(fid2,'p\_up2 : %f \n', 0.55);% fprintf(fid2,'%%%% Upper soil water depletion threshold for water stress

 $\hookrightarrow$  effects on canopy senescence  $\% \ n'$ );

```
fprintf(fid2, 'p_up3 : %f \n', 0.7);%
    fprintf(fid2,'%%%% Upper soil water depletion threshold for water stress
        \hookrightarrow effects on canopy pollination \% \ n');
   fprintf(fid2,'p_up4 : %f \n', -999);%
675
    fprintf(fid2,'%%%% Lower soil water depletion threshold for water stress
        \hookrightarrow effects on canopy expansion \% n');
    fprintf(fid2,'p_lo1 : %f \n', 0.7);%
    fprintf(fid2,'%%%% Lower soil water depletion threshold for water stress
        \hookrightarrow effects on canopy stomatal control \% \n';
    fprintf(fid2,'p_lo2 : %f \n', 1); %
    fprintf(fid2,'%%%% Lower soil water depletion threshold for water stress
680
        \hookrightarrow effects on canopy senescence %% \n');
    fprintf(fid2,'p_lo3 : %f \n', 1);%
    fprintf(fid2,'%%% Lower soil water depletion threshold for water stress
        \hookrightarrow effects on canopy pollination \% \ n');
    fprintf(fid2,'p_lo4 : %f \n', -999);%
    fprintf(fid2, '%%% Shape factor describing water stress effects on canopy
        \hookrightarrow expansion \% \n');
   fprintf(fid2,'fshape_w1 : %f \n', 3);
685
    fprintf(fid2,'%%% Shape factor describing water stress effects on stomatal
        \hookrightarrow control %% \n');
    fprintf(fid2,'fshape_w2 : %f \n', 3);
    fprintf(fid2, '%%% Shape factor describing water stress effects on canopy
       \hookrightarrow senescence \% \n');
    fprintf(fid2,'fshape_w3 : %f \n', 3);
   fprintf(fid2, '%%%% Shape factor describing water stress effects on pollination
690
        \hookrightarrow %% \n');
    fprintf(fid2,'fshape_w4 : %f \n', -999);
    fprintf(fid2,'%%% Adjustment to water stress thresholds depending on daily ETO
        \hookrightarrow (0: No, 1: Yes) %% \n');
    fprintf(fid2,'ETadj : %f \n', 1);
    fprintf(fid2,'%%%% Vol below saturation at which stress begins to occur due to
        \hookrightarrow deficient aeration \% n');
    fprintf(fid2,'Aer : %f \n', 5);
695
    fprintf(fid2,'%%%% Number of days lag before aeration stress affects crop
        \hookrightarrow growth %% \n');
    fprintf(fid2,'LagAer : %f \n', 3);
    fprintf(fid2,'%%%% Reduction to p_lo3 when early canopy senescence is triggered
        \hookrightarrow %% \n');
    fprintf(fid2,'beta : %f \n', 12);
   fprintf(fid2, '%%%% Proportion of total water storage needed for crop to
700
        \hookrightarrow germinate \% (n');
```

```
fprintf(fid2,'GermThr : %f \n', 0.2);
    fclose(fid2);
    end
705
    elseif cropt==5
    %Sorghum
    crop={'Sorghum'};
    for i=1:1
710 fid2 = fopen('Crop.txt','wt');
    fprintf(fid2,'%%%% ------ Crop parameters for AquaCropOS ----- %%\n');
    fprintf(fid2,'%%%% Crop Type (1: Leafy vegetable, 2: Root/tuber, 3: Fruit/grain
       \leftrightarrow ) %%\n');
    fprintf(fid2,'CropType : %f\n', 3);%
715 fprintf(fid2,'%%%% Calendar Type (1: Calendar days, 2: Growing degree days)\n')
       \hookrightarrow;
    fprintf(fid2,'CalendarType : %f \n', 2);%
    fprintf(fid2,'%%%% Convert calendar to GDD mode if inputs are given in calendar
       \hookrightarrow days (0: No; 1: Yes) %/\n');
    fprintf(fid2,'SwitchGDD : %f \n', 1); %
    fprintf(fid2,'%%% Planting Date (dd/mm) %%\n');
720 fprintf(fid2,'PlantingDate : %s \n','01/09'); %
    fprintf(fid2,'%%%% Latest Harvest Date (dd/mm) %%\n');
    fprintf(fid2, 'HarvestDate : %s \n', '30/12'); %
    fprintf(fid2,'%%%% Growing degree/Calendar days from sowing to emergenc \n');
    fprintf(fid2,'Emergence : %f \n', 136);%
725 fprintf(fid2, '%%%% Growing degree/Calendar days from sowing to \n');
    fprintf(fid2, 'MaxRooting : %f \n', 1583); %
    fprintf(fid2,'%%%% Growing degree/Calendar days from sowing to senescence %%\n'
       \rightarrow):
    fprintf(fid2, 'Senescence : %f \n', 1579); %
    fprintf(fid2,'%%%% Growing degree/Calendar days from sowing to maturity %% \n')
       \leftrightarrow;
730 fprintf(fid2, 'Maturity : %f \n', 1760); %
    fprintf(fid2,'%%%% Growing degree/Calendar days from sowing to start of yield
       \hookrightarrow formation \% n');
    fprintf(fid2,'HIstart : %f \n', 1041);%
    fprintf(fid2,'%%%% Duration of flowering in growing degree/calendar days (-999
       \hookrightarrow for non-fruit/grain crops) %% \n');
    fprintf(fid2,'Flowering : %f \n', 306); %
```

```
fprintf(fid2, '%%%% Duration of yield formation in growing degree/calendar days
735
       \hookrightarrow %% \n');
    fprintf(fid2,'YldForm : %f \n', 719);%
    fprintf(fid2,'%%%% Growing degree day calculation method %% \n');
    fprintf(fid2,'GDDmethod : %f \n', 2);%
    fprintf(fid2,'%%%% Base temperature (degC) below which growth does not progress
       \hookrightarrow %% \n');
   fprintf(fid2,'Tbase : %f \n', 8);%
740
    fprintf(fid2,'%%%% Upper temperature (degC) above which crop development no
       \hookrightarrow longer increases \% \n');
    fprintf(fid2,'Tupp : %f \n', 30); %
    fprintf(fid2,'%%%% Pollination affected by heat stress (0: No; 1: Yes) %% \n');
    fprintf(fid2,'PolHeatStress : %f \n', 1);%
745 fprintf(fid2,'%%% Maximum air temperature (degC) above which pollination
       \hookrightarrow begins to fail \% (n');
    fprintf(fid2,'Tmax_up : %f \n', 40);%
    fprintf(fid2,'%%%% Maximum air temperature (degC) at which pollination
       \hookrightarrow completely fails \% \n');
    fprintf(fid2,'Tmax_lo : %f \n', 45);%
    fprintf(fid2,'%%% Pollination affected by cold stress (0: No; 1: Yes) %% \n');
   fprintf(fid2,'PolColdStress : %f \n', 1);8
750
    fprintf(fid2,'%%% Minimum air temperature (degC) below which pollination
        \hookrightarrow begins to fail \% \ n';
    fprintf(fid2,'Tmin_up : %f \n', 10);%
    fprintf(fid2,'%%%% Minimum air temperature (degC) at which pollination
       \hookrightarrow completely fails \% n');
    fprintf(fid2,'Tmin_lo : %f \n', 5);%
   fprintf(fid2, '%%%% Biomass production affected by temperature stress (0: No; 1:
755
       \hookrightarrow Yes) %% \n');
    fprintf(fid2,'BioTempStress : %f \n', 1);
    fprintf(fid2,'%%% Minimum growing degree days (degC/day) required for full
        \hookrightarrow biomass production \% n');
    fprintf(fid2,'GDD_up : %f \n', 12);%
    fprintf(fid2, %%%% Growing degree days (degC/day) at which no biomass
        \hookrightarrow production occurs \% (n');
   fprintf(fid2,'GDD_lo : %f \n', 0); %
760
    fprintf(fid2,'%%%% Shape factor describing the reduction in biomass productig
       \hookrightarrow degree days %% \n');
    fprintf(fid2,'fshape_b : %f \n', 13.8135);%
    fprintf(fid2,'%%%% Initial percentage of minimum effective rooting depth %% \n'
        \rightarrow);
    fprintf(fid2,'PctZmin : %f \n', 70);%
```

```
765 [fprintf(fid2,'%%%% Minimum effective rooting depth (m) %% \n');
    fprintf(fid2,'Zmin : %f \n', 0.30);%
    fprintf(fid2,'%%%% Maximum rooting depth (m) %% \n');
    fprintf(fid2,'Zmax : %f \n', 1.8);%
    fprintf(fid2, '%%%% Shape factor describing root expansion %% \n');
770 [fprintf(fid2,'fshape_r : %f \n', 1.3);%
    fprintf(fid2, '%%%% Shape factor describing the effects of water stress on root
       \hookrightarrow expansion \% (n');
    fprintf(fid2,'fshape_ex : %f \n', -6);%
    fprintf(fid2,'%%%% Maximum root water extraction at top of the root zone (m3/m3
        \hookrightarrow /day) %% \n');
    fprintf(fid2,'SxTopQ : %f \n', 0.016); %
775 [fprintf(fid2,'%%%% Maximum root water extraction at the bottom of the root zone
        \hookrightarrow (m3/m3/day) %% \n');
    fprintf(fid2,'SxBotQ : %f \n', 0.004);%
    fprintf(fid2, '%%%% Exponent parameter for adjustment of Kcx once senescence is
        \hookrightarrow triggered %% \n');
    fprintf(fid2,'a_Tr : %f \n', 1);%
    fprintf(fid2,'%%%% Soil surface area (cm2) covered by an individual seedling %%
       \rightarrow \ \ \ );
780 fprintf(fid2, 'SeedSize : %f \n', 3); %
    fprintf(fid2,'%%%% Number of plants per hectare %% \n');
    fprintf(fid2,'PlantPop : %f \n', 200000);%
    fprintf(fid2,'%%%% Minimum canopy size below which yield formation cannot occur
        \hookrightarrow %% \n');
    fprintf(fid2, 'CCmin : %f \n', 0.006); %
785 [fprintf(fid2, '%%%% Maximum canopy cover (fraction of soil cover) %% \n');
    fprintf(fid2,'CCx : %f \n', 0.9);%
    fprintf(fid2,'%%%% Canopy decline coefficient (fraction per day/GDD) %% \n');
    fprintf(fid2,'CDC : %f \n', 0.009862); %
    fprintf(fid2,'%%%% Canopy growth coefficient (fraction per day/GDD) %% \n');
790 [fprintf(fid2,'CGC : %f \n', 0.012);%
    fprintf(fid2,'%%%% Crop coefficient when canopy growth is complete but prior to
        \hookrightarrow senescence \% (n');
    fprintf(fid2,'Kcb : %f \n', 1.07);%
    fprintf(fid2,'%%%% Decline of crop coefficient due to ageing (day) %% \n');
    fprintf(fid2,'fage : %f \n', 0.3);%
795 [fprintf(fid2,'%%%% Water productivity normalized for ETO and CO2 (g/m2) %% \n')
        \hookrightarrow :
    fprintf(fid2,'WP : %f \n', 33.7);%
    fprintf(fid2, %%%% Adjustment of water productivity in yield formation stage (
       \hookrightarrow of WP) %% \n');
```

```
fprintf(fid2,'WPy : %f \n', 100);%
    fprintf(fid2, '%%%% Crop co2 sink strength coefficient %% \n');
   fprintf(fid2,'fsink : %f \n', 0.5);%
800
    fprintf(fid2,'%%% WP co2 adjustment parameter given by Steduto et al. 2007 %%
       \hookrightarrow \langle n' \rangle:
    fprintf(fid2,'bsted : %f \n', 0.000138);%
    fprintf(fid2,'%%%% WP co2 adjustment parameter given by FACE experiments %% \n'
       \rightarrow);
    fprintf(fid2,'bface : %f \n', 0.001165);%
   fprintf(fid2,'%%%% Reference harvest index %% \n');
805
    fprintf(fid2,'HI0 : %f \n', 0.45);%
    fprintf(fid2,'%%%% Initial harvest index %% \n');
    fprintf(fid2,'HIini : %f \n', 0.01);%
    fprintf(fid2, '%%% Possible increase of harvest index due to water stress
       \hookrightarrow before flowering %% \n');
   fprintf(fid2,'dHI pre : %f \n', 4);%
810
    fprintf(fid2,'%%%% Coefficient describing positive ed vegetative formation %% \
       \rightarrow n');
    fprintf(fid2, 'a_HI : %f \n', 1); %
    fprintf(fid2,'%%%% Coefficient describing negative impact on harves %% \n');
    fprintf(fid2, 'b_HI : %f \n', 3); %
815 [fprintf(fid2,'%%% Maximum allowable increase of harvest index above reference
       \hookrightarrow %% \n');
    fprintf(fid2,'dHI0 : %f \n', 25);%
    fprintf(fid2,'%%%% Crop Determinancy (0: Indeterminant, 1: Determinant) %% \n')
       \hookrightarrow :
    fprintf(fid2, 'Determinant : %f \n', 1);%
    fprintf(fid2,'%%%% Excess of potential fruits %% \n');
   fprintf(fid2,'exc : %f \n', 100);%
820
    fprintf(fid2,'%%%% Percentage of total flowering at which peak flowering occurs
       \rightarrow %% \n'):
    fprintf(fid2, 'MaxFlowPct : %f \n', 33.33); %
    fprintf(fid2,'%%%% Upper soil water depletion threshold for water stress
        \hookrightarrow effects on affect canopy expansion \% \n';
    fprintf(fid2,'p_up1 : %f \n', 0.15);%
   fprintf(fid2,'%%%% Upper soil water depletion threshold for water stress
825
        \hookrightarrow effects on canopy stomatal control \% \n';
    fprintf(fid2,'p_up2 : %f \n', 0.7);8
    fprintf(fid2,'%%%% Upper soil water depletion threshold for water stress
        \hookrightarrow effects on canopy senescence \% n');
    fprintf(fid2,'p_up3 : %f \n', 0.7);%
```

fprintf(fid2,'%%%% Upper soil water depletion threshold for water stress  $\hookrightarrow$  effects on canopy pollination % n');830 **fprintf**(fid2,'p\_up4 : %f \n', 0.8);% fprintf(fid2,'%%%% Lower soil water depletion threshold for water stress  $\hookrightarrow$  effects on canopy expansion % n');**fprintf**(fid2,'p\_lo1 : %f \n', 0.7); % fprintf(fid2,'%%%% Lower soil water depletion threshold for water stress  $\hookrightarrow$  effects on canopy stomatal control %% \n'); fprintf(fid2,'p\_lo2 : %f \n', 1);% 835 [fprintf(fid2,'%%%% Lower soil water depletion threshold for water stress  $\hookrightarrow$  effects on canopy senescence %% \n'); fprintf(fid2,'p\_lo3 : %f \n', 1);% fprintf(fid2,'%%%% Lower soil water depletion threshold for water stress  $\hookrightarrow$  effects on canopy pollination %% \n'); fprintf(fid2,'p\_lo4 : %f \n', 1);% fprintf(fid2,'%%%% Shape factor describing water stress effects on canopy  $\hookrightarrow$  expansion %% \n'); 840 **fprintf**(fid2, 'fshape\_w1 : %f \n', 3); fprintf(fid2,'%%%% Shape factor describing water stress effects on stomatal  $\hookrightarrow$  control %% \n'); fprintf(fid2,'fshape\_w2 : %f \n', 6); fprintf(fid2, '%%%% Shape factor describing water stress effects on canopy  $\hookrightarrow$  senescence % \n'); fprintf(fid2,'fshape\_w3 : %f \n', 3); 845 [fprintf(fid2,'%%%% Shape factor describing water stress effects on pollination  $\hookrightarrow$  %% \n'); fprintf(fid2,'fshape\_w4 : %f \n', 1); fprintf(fid2,'%%% Adjustment to water stress thresholds depending on daily ETO  $\hookrightarrow$  (0: No, 1: Yes) %% \n'); fprintf(fid2,'ETadj : %f \n', 1); fprintf(fid2,'%%%% Vol below saturation at which stress begins to occur due to  $\hookrightarrow$  deficient aeration % n');850 fprintf(fid2,'Aer : %f \n', 5); fprintf(fid2,'%%%% Number of days lag before aeration stress affects crop  $\hookrightarrow$  growth %% \n'); fprintf(fid2,'LagAer : %f \n', 3); fprintf(fid2,'%%% Reduction to p\_lo3 when early canopy senescence is triggered  $\hookrightarrow$  %% \n'); fprintf(fid2,'beta : %f \n', 12); 855 [fprintf(fid2,'%%%% Proportion of total water storage needed for crop to  $\hookrightarrow$  germinate % (n');fprintf(fid2,'GermThr : %f \n', 0.2);

145

```
fclose(fid2);
    end
860
    else
    %Maize
    crop={'Maize'};
    for i=1:1
   fid2 = fopen('Crop.txt','wt');
865
    fprintf(fid2,'%%%% ------ Crop parameters for AquaCropOS ----- %%\n');
    fprintf(fid2,'%%%% Crop Type (1: Leafy vegetable, 2: Root/tuber, 3: Fruit/grain
       \rightarrow ) %%\n');
    fprintf(fid2,'CropType : %f\n', 3);%
   fprintf(fid2, '%%%% Calendar Type (1: Calendar days, 2: Growing degree days)\n')
870
       \hookrightarrow:
    fprintf(fid2,'CalendarType : %f \n', 2); %
    fprintf(fid2,'%%%% Convert calendar to GDD mode if inputs are given in calendar
       \hookrightarrow days (0: No; 1: Yes) %%\n');
    fprintf(fid2,'SwitchGDD : %f \n', 1);%
    fprintf(fid2,'%%%% Planting Date (dd/mm) %%\n');
875 fprintf(fid2,'PlantingDate : %s \n','01/09'); %
    fprintf(fid2, '%%%% Latest Harvest Date (dd/mm) %%\n');
    fprintf(fid2, 'HarvestDate : %s \n', '30/12'); %
    fprintf(fid2,'%%%% Growing degree/Calendar days from sowing to emergenc \n');
    fprintf(fid2,'Emergence : %f \n', 80);%
   fprintf(fid2, '%%%% Growing degree/Calendar days from sowing to \n');
880
    fprintf(fid2, 'MaxRooting : %f \n', 1400); %
    fprintf(fid2,'%%%% Growing degree/Calendar days from sowing to senescence %%\n'
       \rightarrow);
    fprintf(fid2,'Senescence : %f \n', 1400);%
    fprintf(fid2,'%%%% Growing degree/Calendar days from sowing to maturity %% \n')
       \hookrightarrow:
   fprintf(fid2,'Maturity : %f \n', 1700); %
885
    fprintf(fid2,'%%%% Growing degree/Calendar days from sowing to start of yield
       \hookrightarrow formation \% (n');
    fprintf(fid2,'HIstart : %f \n', 880);%
    fprintf(fid2, '%%% Duration of flowering in growing degree/calendar days (-999
        \hookrightarrow for non-fruit/grain crops) %% \n');
    fprintf(fid2,'Flowering : %f \n', 180);%
   fprintf(fid2, '%%%% Duration of yield formation in growing degree/calendar days
890
       \hookrightarrow %% \n');
```

	fprintf(fid2,'YldForm : %f \n', 750);%
	<pre>fprintf(fid2,'%%%% Growing degree day calculation method %% \n');</pre>
	fprintf(fid2,'GDDmethod : %f \n', 2);8
	<pre>fprintf(fid2,'%%%% Base temperature (degC) below which growth does not progress</pre>
	$\leftrightarrow$ %% \n');
895	<pre>fprintf(fid2,'Tbase : %f \n', 8);%</pre>
	<pre>fprintf(fid2,'%%%% Upper temperature (degC) above which crop development no</pre>
	$\hookrightarrow$ longer increases %% \n');
	fprintf(fid2,'Tupp : %f \n', 30); %
	<pre>fprintf(fid2,'%%%% Pollination affected by heat stress (0: No; 1: Yes) %% \n');</pre>
	fprintf(fid2,'PolHeatStress : %f \n', 1);8
900	<pre>fprintf(fid2,'%%%% Maximum air temperature (degC) above which pollination</pre>
	$\hookrightarrow$ begins to fail %% \n');
	<pre>fprintf(fid2,'Tmax_up : %f \n', 40);%</pre>
	<pre>fprintf(fid2,'%%%% Maximum air temperature (degC) at which pollination</pre>
	$\hookrightarrow$ completely fails %% \n');
	<pre>fprintf(fid2,'Tmax_lo : %f \n', 45);%</pre>
	<pre>fprintf(fid2,'%%%% Pollination affected by cold stress (0: No; 1: Yes) %% \n');</pre>
905	<pre>fprintf(fid2,'PolColdStress : %f \n', 1);%</pre>
	<pre>fprintf(fid2,'%%%% Minimum air temperature (degC) below which pollination</pre>
	$\hookrightarrow$ begins to fail %% \n');
	<pre>fprintf(fid2,'Tmin_up : %f \n', 10);%</pre>
	<pre>fprintf(fid2,'%%%% Minimum air temperature (degC) at which pollination</pre>
	$\hookrightarrow$ completely fails %% \n');
	<pre>fprintf(fid2,'Tmin_lo : %f \n', 5);%</pre>
910	<pre>fprintf(fid2,'%%%% Biomass production affected by temperature stress (0: No; 1:</pre>
	$\leftrightarrow$ Yes) %% \n');
	<pre>fprintf(fid2,'BioTempStress : %f \n', 1);%</pre>
	<pre>fprintf(fid2,'%%%% Minimum growing degree days (degC/day) required for full</pre>
	$\hookrightarrow$ biomass production %% \n');
	<b>fprintf(fid2,</b> 'GDD_up : %f \n', 12);%
	<pre>fprintf(fid2,'%%%% Growing degree days (degC/day) at which no biomass</pre>
	$\hookrightarrow$ production occurs %% \n');
915	fprintf(fid2,'GDD_lo : %f \n', 0);8
	<pre>fprintf(fid2,'%%%% Shape factor describing the reduction in biomass productig</pre>
	$\hookrightarrow$ degree days %% \n');
	<b>fprintf(fid2,</b> 'fshape_b : %f \n', 13.8135);%
	<pre>fprintf(fid2,'%%%% Initial percentage of minimum effective rooting depth %% \n'</pre>
	$\leftrightarrow$ );
	<pre>fprintf(fid2,'PctZmin : %f \n', 70);%</pre>
920	<pre>fprintf(fid2,'%%%% Minimum effective rooting depth (m) %% \n');</pre>
	<b>fprintf(fid2,</b> 'Zmin : %f \n', 0.30);%

```
fprintf(fid2,'%%%% Maximum rooting depth (m) %% \n');
    fprintf(fid2,'Zmax : %f \n', 2);%
    fprintf(fid2, '%%%% Shape factor describing root expansion %% \n');
   fprintf(fid2,'fshape_r : %f \n', 1.3);%
925
    fprintf(fid2,'%%%% Shape factor describing the effects of water stress on root
       \hookrightarrow expansion \% (n');
    fprintf(fid2,'fshape_ex : %f \n', -6);%
    fprintf(fid2,'%%%% Maximum root water extraction at top of the root zone (m3/m3
       \hookrightarrow /day) %% \n');
    fprintf(fid2,'SxTopQ : %f \n', 0.0104); %
   fprintf(fid2,'%%%% Maximum root water extraction at the bottom of the root zone
930
       \hookrightarrow (m3/m3/day) %% \n');
    fprintf(fid2,'SxBotQ : %f \n', 0.0026);%
    fprintf(fid2,'%%%% Exponent parameter for adjustment of Kcx once senescence is
       \hookrightarrow triggered %% \n');
    fprintf(fid2, 'a_Tr : %f \n', 1);%
    fprintf(fid2,'%%%% Soil surface area (cm2) covered by an individual seedling %%
       \hookrightarrow \ \ \ ):
   fprintf(fid2,'SeedSize : %f \n', 6.5); %
935
    fprintf(fid2,'%%%% Number of plants per hectare %% \n');
    fprintf(fid2, 'PlantPop : %f \n', 75000); %
    fprintf(fid2,'%%%% Minimum canopy size below which yield formation cannot occur
        \hookrightarrow %% \n');
    fprintf(fid2,'CCmin : %f \n', 0.049);%
   fprintf(fid2,'%%%% Maximum canopy cover (fraction of soil cover) %% \n');
940
    fprintf(fid2,'CCx : %f \n', 0.96);%
    fprintf(fid2,'%%%% Canopy decline coefficient (fraction per day/GDD) %% \n');
    fprintf(fid2,'CDC : %f \n', 0.01); %
    fprintf(fid2,'%%%% Canopy growth coefficient (fraction per day/GDD) %% \n');
   fprintf(fid2,'CGC : %f \n', 0.0125); %
945
    fprintf(fid2,'%%%% Crop coefficient when canopy growth is complete but prior to
        \hookrightarrow senescence \% n');
    fprintf(fid2,'Kcb : %f \n', 1.05);%
    fprintf(fid2,'%%%% Decline of crop coefficient due to ageing (day) %% \n');
    fprintf(fid2,'fage : %f \n', 0.3); %
   fprintf(fid2,'%%%% Water productivity normalized for ETO and CO2 (g/m2) %% \n')
950
        \hookrightarrow ;
    fprintf(fid2,'WP : %f \n', 33.7); %
    fprintf(fid2,'%%%% Adjustment of water productivity in yield formation stage (
       \hookrightarrow of WP) %% \n');
    fprintf(fid2,'WPy : %f \n', 100); %
    fprintf(fid2,'%%%% Crop co2 sink strength coefficient %% \n');
```

```
955 fprintf(fid2,'fsink : %f \n', 0.5);%
    fprintf(fid2,'%%%% WP co2 adjustment parameter given by Steduto et al. 2007 %%
        \hookrightarrow \langle n' \rangle;
    fprintf(fid2,'bsted : %f \n', 0.000138);%
    fprintf(fid2,'%%%% WP co2 adjustment parameter given by FACE experiments %% \n'
        \rightarrow);
    fprintf(fid2,'bface : %f \n', 0.001165);%
960 [fprintf(fid2,'%%%% Reference harvest index %% \n');
    fprintf(fid2,'HI0 : %f \n', 0.48);%
    fprintf(fid2,'%%%% Initial harvest index %% \n');
    fprintf(fid2,'HIini : %f \n', 0.01);%
    fprintf(fid2,'%%%% Possible increase of harvest index due to water stress
        \hookrightarrow before flowering %% \n');
965 fprintf(fid2,'dHI_pre : %f \n', 0); %
    fprintf(fid2,'%%%% Coefficient describing positive ed vegetative formation %% \
       \rightarrow n'):
    fprintf(fid2, 'a_HI : %f \n', 7);8
    fprintf(fid2,'%%%% Coefficient describing negative impact on harves %% \n');
    fprintf(fid2, 'b_HI : %f \n', 3); %
970 [fprintf(fid2,'%%% Maximum allowable increase of harvest index above reference
        \hookrightarrow %% \n');
    fprintf(fid2,'dHI0 : %f \n', 15);%
    fprintf(fid2,'%%%% Crop Determinancy (0: Indeterminant, 1: Determinant) %% \n')
        \hookrightarrow:
    fprintf(fid2,'Determinant : %f \n', 1); %
    fprintf(fid2,'%%%% Excess of potential fruits %% \n');
975 fprintf(fid2, 'exc : %f \n', 50); %
    fprintf(fid2,'%%%% Percentage of total flowering at which peak flowering occurs
        \hookrightarrow %% \n');
    fprintf(fid2,'MaxFlowPct : %f \n', 33.33);%
    fprintf(fid2,'%%%% Upper soil water depletion threshold for water stress
        \hookrightarrow effects on affect canopy expansion \% \n';
    fprintf(fid2,'p_up1 : %f \n', 0.14);%
980 [fprintf(fid2,'%%%% Upper soil water depletion threshold for water stress
        \hookrightarrow effects on canopy stomatal control \% n');
    fprintf(fid2,'p_up2 : %f \n', 0.69);%
    fprintf(fid2,'%%%% Upper soil water depletion threshold for water stress
        \hookrightarrow effects on canopy senescence \% \n');
    fprintf(fid2,'p_up3 : %f \n', 0.69);%
    fprintf(fid2,'%%%% Upper soil water depletion threshold for water stress
        \hookrightarrow effects on canopy pollination \% n');
985 fprintf(fid2,'p_up4 : %f \n', 0.8);%
```

```
fprintf(fid2,'%%%% Lower soil water depletion threshold for water stress
        \hookrightarrow effects on canopy expansion \% n');
     fprintf(fid2,'p_lo1 : %f \n', 0.72);%
     fprintf(fid2,'%%%% Lower soil water depletion threshold for water stress
         \hookrightarrow effects on canopy stomatal control %% \n');
     fprintf(fid2,'p_lo2 : %f \n', 1); %
    fprintf(fid2,'%%%% Lower soil water depletion threshold for water stress
990
        \hookrightarrow effects on canopy senescence \% \n');
     fprintf(fid2,'p_lo3 : %f \n', 1);%
     fprintf(fid2,'%%%% Lower soil water depletion threshold for water stress
         \hookrightarrow effects on canopy pollination \% \ n');
     fprintf(fid2,'p_lo4 : %f \n', 1);8
     fprintf(fid2, '%%% Shape factor describing water stress effects on canopy
        \hookrightarrow expansion \% n');
    fprintf(fid2,'fshape_w1 : %f \n', 2.9);
995
     fprintf(fid2,'%%% Shape factor describing water stress effects on stomatal
        \hookrightarrow control %% \n');
     fprintf(fid2,'fshape_w2 : %f \n', 6);
     fprintf(fid2, '%%%% Shape factor describing water stress effects on canopy
        \hookrightarrow senescence \% \n');
     fprintf(fid2,'fshape_w3 : %f \n', 2.7);
    fprintf(fid2, '%%%% Shape factor describing water stress effects on pollination
1000
         \hookrightarrow %% \n');
     fprintf(fid2,'fshape_w4 : %f \n', 1);
     fprintf(fid2,'%%%% Adjustment to water stress thresholds depending on daily ETO
        \hookrightarrow (0: No, 1: Yes) %% \n');
     fprintf(fid2,'ETadj : %f \n', 1);
     fprintf(fid2, '%%%% Vol below saturation at which stress begins to occur due to
         \hookrightarrow deficient aeration \% n');
    fprintf(fid2,'Aer : %f \n', 5);
1005
    fprintf(fid2,'%%%% Number of days lag before aeration stress affects crop
        \hookrightarrow growth %% \n');
     fprintf(fid2,'LagAer : %f \n', 3);
     fprintf(fid2,'%%%% Reduction to p_lo3 when early canopy senescence is triggered
        \hookrightarrow %% \n');
    fprintf(fid2,'beta : %f \n', 12);
    fprintf(fid2, '%%%% Proportion of total water storage needed for crop to
1010
        \hookrightarrow germinate \% \n');
     fprintf(fid2,'GermThr : %f \n', 0.2);
     fclose(fid2);
     end
```

```
1015
    end
     %Crop mix file
    for i=1
1020 fid2 = fopen('CropMix.txt','wt');
    fprintf(fid2,'%%%% ------ Crop mix options for AquaCropOS ----- %% \n'
        \rightarrow);
    fprintf(fid2, '%%%% Number of crop options %% \n');
    fprintf(fid2,'%f \n',1);
    fprintf(fid2, '%%%% Specified planting calendar %% \n');
1025 fprintf(fid2,'N \n');
    fprintf(fid2,'%%%% Crop rotation filename %% \n');
    fprintf(fid2, 'CropRotation.txt \n');
    fprintf(fid2,'%%%% Information about each crop type %% \n');
    fprintf(fid2,'%%%% CropType, CropFilename, IrrigationFilename %% \n');
    fprintf(fid2,'%s, Crop.txt, IrrigationManagement.txt \n',crop{:});
1030
    fclose(fid2);
    end
1035 & Crop Rotation file
    for i=1:1
    fid2 = fopen('CropRotation.txt','wt');
    fprintf(fid2,'%%%% ------ Crop rotation time-series for AquaCropOS ------
        \hookrightarrow %% \n');
    fprintf(fid2,'%%%% PlantDate HarvestDate Crop %% \n');
1040 [fprintf(fid2,'01/05/2019 30/09/2019 %s \n',crop{:});
    fclose(fid2);
    end
     %FieldManagement.txt
1045
    if mane==1
        Mulches=0;
        fMulch=0.5:
    elseif mane==2
        Mulches=1;
1050
        fMulch=0.5;
    else
        Mulches=1;
        fMulch=1;
    end
```

```
for i=1:1
1055
    fid2 = fopen('FieldManagement.txt','wt');
    fprintf(fid2,'%%%% -- Soil parameter inputs for AquaCropOS %%%%\n');
    fprintf(fid2,'%%%% Soil surface covered by mulches (0: No; 1: Yes) %%%%/n');
    fprintf(fid2,'Mulches : %f \n', Mulches);
1060
    fprintf(fid2,'%%%% Area of soil surface covered by mulches during growing \n');
    fprintf(fid2,'MulchPctGS : %f \n', 50);
    fprintf(fid2,'%%%% Area of soil surface covered by mulches outside growing \n')
        \hookrightarrow ;
    fprintf(fid2, 'MulchPctOS : %f \n', 50);
   fprintf(fid2,'%%%% Soil evaporation adjustment factor due to effect of mulches
1065
        \rightarrow %%\n');
    fprintf(fid2,'fMulch : %f \n', fMulch);
    fprintf(fid2, '%%%% Surface bunds present (0: No; 1: Yes) %%\n');
    fprintf(fid2, 'Bunds : %f \n', 0);
    fprintf(fid2, '%%%% Bund height (m) %%\n');
1070 fprintf(fid2, 'zBund : %f \n', 0);
    fprintf(fid2,'%%%% Initial water height in surface bunds (mm) %%\n');
    fprintf(fid2,'BundWater : %f \n', 0);
    fclose(fid2);
1075
    end
     %Running AquaCrop Model
    AquaCropOS_RUN
1080
     %reading Aquacrop output data
    temp=importdata('Sample_WaterFluxes.txt');
    WaterFluxes=temp.data;
    clear temp;
1085
    Es=sum(WaterFluxes(:,15)); % (mm) Evaporation from soil surface
    Tr=sum(WaterFluxes(:,17)); %(mm) Crop transpiration
1090
    if irrig==1
        Es=Es/0.5;
    elseif irrig==2
        Es=Es/0.6;
    elseif irrig==3
```

```
1095
        Es=Es/0.7;
    elseif irrig==4
        Es=Es/0.8;
    elseif irrig==5
        Es=Es/0.9;
    else
1100
        Es=Es/0.95;
    end
1105 temp=importdata('Sample_FinalOutput.txt');
    FinalOutput=temp.data;
    clear temp;
    Yield=sum(FinalOutput(:,2)); %(ton/ha) Crop Yield
1110
    if cropt==3
        if irrig==1
            matriz_TotIrr(cropt,irrig,mane)=sum(FinalOutput(:,3))/0.5;% (mm) Total

→ Irrigation

        elseif irrig==2
            matriz_TotIrr(cropt,irrig,mane)=sum(FinalOutput(:,3))/0.6;
1115
        elseif irrig==3
            matriz_TotIrr(cropt,irrig,mane)=sum(FinalOutput(:,3))/0.7;
        elseif irrig==4
            matriz_TotIrr(cropt,irrig,mane)=sum(FinalOutput(:,3))/0.8;
        elseif irrig==5
1120
            matriz_TotIrr(cropt,irrig,mane)=sum(FinalOutput(:,3))/0.9;
        else
            matriz_TotIrr(cropt,irrig,mane)=sum(FinalOutput(:,3))/0.95;
        end
1125
    else
        if irrig==1
            matriz_TotIrr(cropt,irrig,mane)=sum(FinalOutput(:,3))/(2*0.5); % (mm)
               ← Total Irrigation
        elseif irrig==2
1130
            matriz_TotIrr(cropt,irrig,mane)=sum(FinalOutput(:,3))/(2*0.6);
        elseif irrig==3
            matriz_TotIrr(cropt,irrig,mane)=sum(FinalOutput(:,3))/(2*0.7);
        elseif irrig==4
            matriz_TotIrr(cropt,irrig,mane)=sum(FinalOutput(:,3))/(2*0.8);
```

```
1135
        elseif irrig==5
            matriz_TotIrr(cropt,irrig,mane)=sum(FinalOutput(:,3))/(2*0.9);
        else
            matriz_TotIrr(cropt,irrig,mane)=sum(FinalOutput(:,3))/(2*0.95);
        end
    end
1140
    matriz_PH(cropt,irrig,mane)=10*(Es+Tr)/Yield; %(1/kg)
    end
    end
1145
    end
    cont_interacao=0;
    cont_parada=0;
    parar=0;
1150
    while parar==0
    for ger=1:n_ger
   PH=zeros(1,n_usuarios,n_popu);
1155
    Q_total=zeros(n_popu);
    TotIrr=zeros(1,n_usuarios,n_popu);
    for creature=1:n_popu
    for user=1:n_usuarios
        TotIrr(1,user,creature)=matriz_TotIrr(popu_inicial(1,user,creature),
1160

→ popu_inicial(2,user,creature),popu_inicial(3,user,creature));

        PH(1,user,creature)=matriz_PH(popu_inicial(1,user,creature),popu_inicial(2,

    user,creature),popu_inicial(3,user,creature));

    end
    for u=1:n usuarios
        %flow to irrigate total area
        Q_total(creature)=Q_total(creature)+TotIrr(1,u,creature)*A_max(u)/(1000*
1165

→ t_sec(popu_inicial(1,user,creature)));

    end
     end
     ୫୫୫୫୫୫୫୫୫୫୫୫୫୫୫୫୫୫୫୫୫୫୫୫୫୫୫
    %Feasibility of solutions
1170
    inviaveis=zeros(n_popu);
     %Calculates the cost of each individual
```

```
custo=zeros(1,1,n_popu);
    for k=1:n_popu
1175
        for j=1:n_usuarios
           for i=2:3
               if popu_inicial(i,j,k)>IniConfig(i,j)
                  custo(1,1,k)=custo(1,1,k)+cost(i,popu_inicial(i,j,k))*A_max(j);
1180
               end
           end
        end
        if custo(1,1,k)>custo_limite
           inviaveis(k)=1;
1185
        end
    end
    %Unviability by demand greater than availability
    for u=1:n_popu
        if Q_total(u)>q_100
1190
           inviaveis(u)=1;
        end
    end
    ୫୫୫୫୫୫୫୫୫୫୫୫୫୫୫୫୫୫୫୫୫୫୫୫୫୫୫
1195
    %Objective functions
    %calculation of objective functions
    aptidao=zeros(1,n_funcoes,n_popu); % creating matrix to store the value of
        → fitness
1200
    %calculation of the first objective function
    for k=1:n_popu
        aptidao(1,1,k) = sum(PH(1,:,k));
    end
1205
    %calculation of the second objective function
    aptidao(1,2,:) = custo(1,1,:);
    %standardization of fitness values
1210 maior_aptidao=max(aptidao,[],3);
    menor_aptidao=min(aptidao,[],3);
    aptidao_norm=zeros(1,n_funcoes,n_popu);
    for k=1:n_popu
```

```
1215
       aptidao_norm(:,:,k)=100*(aptidao(:,:,k)-menor_aptidao)./(maior_aptidao-
           \hookrightarrow menor_aptidao);
    end
    %Strength of individuals
    strength=zeros(n_popu);
    for i=1:n_popu
1220
       if inviaveis(i)==0
           for j=1:n_popu
              if inviaveis(j)==0
                 if and(and(aptidao_norm(:,1,i)<=aptidao_norm(:,1,j),aptidao_norm</pre>
                     → aptidao_norm(:,1,j),aptidao_norm(:,2,i)<aptidao_norm(:,2,j</pre>
                     \rightarrow )))
                     strength(i)=strength(i)+1;
1225
                 end
              end
           end
       else
           for j=1:n_popu
1230
              if inviaveis(j)==1
                 if and(and(aptidao_norm(:,1,i)<=aptidao_norm(:,1,j),aptidao_norm</pre>
                     ↔ aptidao_norm(:,1,j),aptidao_norm(:,2,i)<aptidao_norm(:,2,j</pre>
                     \rightarrow )))
                     strength(i)=strength(i)+1;
                 end
1235
              end
           end
       end
    end
    %Raw Fitness of individuals
1240
    raw_fitness=zeros(n_popu);
    for i=1:n_popu
       if inviaveis(i)==0
           for j=1:n_popu
1245
              if inviaveis(j)==0
                 if and(and(aptidao_norm(:,1,i)<=aptidao_norm(:,1,j),aptidao_norm</pre>
                     → aptidao_norm(:,1,j),aptidao_norm(:,2,i)<aptidao_norm(:,2,j</pre>
                     \rightarrow )))
```

```
raw_fitness(j)=raw_fitness(j)+strength(i);
                  end
               end
           end
1250
        else
           for j=1:n_popu
               if inviaveis(j)==1
                  if and(and(aptidao_norm(:,1,i)<=aptidao_norm(:,1,j),aptidao_norm</pre>
                      → aptidao_norm(:,1,j),aptidao_norm(:,2,i)<aptidao_norm(:,2,j</pre>
                      \rightarrow )))
                      raw_fitness(j)=raw_fitness(j)+strength(i);
1255
                  end
               end
           end
        end
1260
    end
    %Calculation of neighborhood density of individuals
    distancia_euclidiana=NaN(n_popu,n_popu);
    for i=1:n_popu
1265
        restante=i+1;
        for j=restante:n_popu
           distancia_euclidiana(i,j)=sqrt((aptidao_norm(1,1,j)-aptidao_norm(1,1,i))
               \hookrightarrow ^2+(aptidao_norm(1,2,j)-aptidao_norm(1,2,i))^2);
           distancia_euclidiana(j,i)=distancia_euclidiana(i,j);
        end
1270
    end
    densidade_vizinhanca=1./(2+distancia_euclidiana);
    %Fitness calculation
    fitness=zeros(n_popu);
    for i=1:n_popu
1275
        temp=densidade_vizinhanca(i,:);
        fitness(i)=max(temp)+raw_fitness(i);
    end
1280
    %filling the external population
    aptidao_ext=zeros(1,n_funcoes,n_popu_ext);
    viabilidade_ext=zeros(n_popu_ext);
    q_ext=zeros(n_popu_ext);
```

```
custo_ext=zeros(n_popu_ext);
```

```
popu_ext=zeros(3,n_usuarios,n_popu_ext); %creating the matrix to store the
1285
            individuals of the external population
    for i=1:n_popu_ext
        %making, initially, the first individual of the population to be
            \hookrightarrow the best individual. After that, it will be compared with
            \hookrightarrow each other individual of the population. If a individual is
            \hookrightarrow found to be better than the best so far, this will be the
            \hookrightarrow new best.
        n_melhor=1;
        viabilidade_melhor=inviaveis(1);
1290
        raw_fitness_melhor=raw_fitness(1);
        aptidao_melhor=fitness(1);
        for j=2:n_popu
            if viabilidade_melhor==0 %if the best individual is viable
                if inviaveis(j)==0 % if the individual in comparison is viable
                   if raw fitness melhor==0 %if the best individual is viable
1295
                       \hookrightarrow and not dominated
                       if raw_fitness(j)==0 %if the individual in comparison is
                           \hookrightarrow viable and not dominated
                           if fitness(j)<aptidao_melhor</pre>
                              n_melhor=j;
                              viabilidade_melhor=inviaveis(j);
                              raw_fitness_melhor=raw_fitness(j);
1300
                              aptidao_melhor=fitness(j);
                           end
                       end
                   else %if the best individual is viable and dominated
                      if raw_fitness(j)==0 %if the individual in comparison is
1305
                          \hookrightarrow viable and not dominated
                          n_melhor=j;
                          viabilidade_melhor=inviaveis(j);
                          raw_fitness_melhor=raw_fitness(j);
                          aptidao_melhor=fitness(j);
                      else %if the individual in comparison is viable and
1310
                          \hookrightarrow dominated
                          if fitness(j)<aptidao_melhor</pre>
                              n_melhor=j;
                              viabilidade_melhor=inviaveis(j);
                              raw_fitness_melhor=raw_fitness(j);
1315
                              aptidao_melhor=fitness(j);
                           end
                      end
```

	end
	end
1320	else %if the best individual is not viable
	if inviaveis(j)==0 %if the individual in comparison is viable
	n_melhor=j;
	viabilidade_melhor=inviaveis(j);
	<pre>raw_fitness_melhor=raw_fitness(j);</pre>
1325	aptidao_melhor=fitness(j);
	else %if the individual in comparison is not viable
	<pre>if raw_fitness_melhor==0 %if the best individual is</pre>
	$\hookrightarrow$ unviable and not dominated
	<pre>if raw_fitness(j)==0 %if the individual in comparison is</pre>
	$\hookrightarrow$ unviable and not dominated
	<pre>if fitness(j)<aptidao_melhor< pre=""></aptidao_melhor<></pre>
1330	n_melhor=j;
	<pre>viabilidade_melhor=inviaveis(j);</pre>
	<pre>raw_fitness_melhor=raw_fitness(j);</pre>
	<pre>aptidao_melhor=fitness(j);</pre>
	end
1335	end
	<b>else</b> %if the best individual is unviable and dominated
	<pre>if raw_fitness(j)==0 %if the individual in comparison is</pre>
	$\hookrightarrow$ unviable and not dominated
	n_melhor=j;
	<pre>viabilidade_melhor=inviaveis(j);</pre>
1340	<pre>raw_fitness_melhor=raw_fitness(j);</pre>
	<pre>aptidao_melhor=fitness(j);</pre>
	<b>else</b> %if the individual in comparison is unviable and
	$\hookrightarrow$ dominated
	<pre>if fitness(j)<aptidao_melhor< pre=""></aptidao_melhor<></pre>
	n_melhor=j;
1345	<pre>viabilidade_melhor=inviaveis(j);</pre>
	<pre>raw_fitness_melhor=raw_fitness(j);</pre>
	<pre>aptidao_melhor=fitness(j);</pre>
	end
	end
1350	end
	end
	end
	end

```
1355
        popu_ext(:,:,i)=popu_inicial(:,:,n_melhor); %storing the best
            \hookrightarrow individual in the external population
        custo_ext(i)=custo(1,1,n_melhor);
        viabilidade_ext(i)=inviaveis(n_melhor);
        q_ext(i)=Q_total(n_melhor);
        aptidao_ext(:,:,i)=aptidao(:,:,n_melhor);
1360
        %removing the best individual (who was transferred to the external
            \hookrightarrow population) from the selection process, so that in the next
            \hookrightarrow cycle the second best will be selected as the best.
        inviaveis(n_melhor)=1;
        raw_fitness(n_melhor)=Inf;
        fitness(n_melhor)=Inf;
1365
    end
     %Transferring the 50 best individuals of this generation directly to
        \hookrightarrow the next generation (Elitism), so as not to lose the best
        \rightarrow solutions found so far.
    for ini=1:50
1370
        popu_inicial(:,:,ini)=popu_ext(:,:,ini);
    end
    for ini=1:10
        if viabilidade_ext(ini)==0
            x=aptidao_ext(1,1,ini);
1375
            y=aptidao_ext(1,2,ini);
            plot(x,y,'b*')
            xlim([10000,19000]);
            ylim([0,custo_limite]);
            xlabel('Water Footprint (l/kg)')
1380
            ylabel('Transition Cost (R$)')
            grid on
            hold on
        end
1385
    end
    filho=IniConfig;
    for i=51:n_popu
1390
     Selection of individuals for reproduction
```

```
%draws two random individuals
    colocacao1=round(rand(1)*n_popu_ext);%saves the individual's
        \hookrightarrow classification (1 is the fittest)
    if colocacao1==0
1395
        colocacao1=1;
    end
    colocacao2=round(rand(1)*n_popu_ext);
    if colocacao2==0
1400
        colocacao2=1;
    end
    %selects the best of both and sends it to reproduction
    if colocacao1<colocacao2</pre>
        pai=popu_ext(:,:,colocacao1);
1405
        colocacao_pai=colocacao1;
    else
        pai=popu_ext(:,:,colocacao2);
        colocacao_pai=colocacao2;
    end
1410
    %repeats the draw for mother's selection
    colocacao3=round(rand(1)*n_popu_ext);
    if colocacao3==0
        colocacao3=1;
1415
    end
    colocacao4=round(rand(1)*n_popu_ext);
    if colocacao4==0
        colocacao4=1;
    end
    if colocacao3>colocacao4
1420
        mae=popu_ext(:,:,colocacao3);
        colocacao_mae=colocacao3;
    else
        mae=popu_ext(:,:,colocacao4);
        colocacao_mae=colocacao4;
1425
    end
    %Performs targeted mutation
    if custo_ext(colocacao_pai)>custo_limite
        for col=1:n_usuarios
1430
            for lin=1:3
```

```
pai(lin,col)=pai(lin,col)-round((pai(lin,col)-IniConfig(lin,col))*
                     \hookrightarrow rand(1));
             end
         end
     end
1435
     if custo_ext(colocacao_mae)>custo_limite
         for col=1:n_usuarios
             for lin=1:3
                 mae(lin,col)=mae(lin,col)-round((mae(lin,col)-IniConfig(lin,col))*
                     \hookrightarrow rand(1));
1440
             end
         end
     end
     % crossover
    sorteado=rand(1);
1445
     if sorteado<=p_cross</pre>
         for col=1:n_usuarios
             for lin=1:3
                 filho(lin,col)=round((pai(lin,col)+mae(lin,col))/2);
1450
             end
         end
     else
         if colocacao_pai>colocacao_mae
             filho=pai;
         else
1455
             filho=mae;
         end
     end
     %performs uniform mutation
1460
     sorteado=rand(1);
     if sorteado<=p_mut</pre>
         for col=1:n_usuarios
             for lin=1:3
1465
                 if lin==1
                     filho(lin,col)=IniConfig(lin,col)+round((n_crop-IniConfig(lin,
                         \hookrightarrow col))*rand(1));
                 elseif lin==2
                     filho(lin,col)=IniConfig(lin,col)+round((n_irrig-IniConfig(lin,
                         \hookrightarrow col))*rand(1));
                 else
```

```
filho(lin,col)=IniConfig(lin,col)+round((n_mane-IniConfig(lin,
1470
                        \hookrightarrow col))*rand(1));
                end
            end
        end
     end
1475
    popu_inicial(:,:,i)=filho;
     end
    cont_interacao=cont_interacao+1;
1480
     fprintf('I'm in genaration %i \n', cont_interacao)
     if viabilidade_ext(1)==0
        fprintf('The best individual is viable \n')
        cont_parada=cont_parada+1;
    end
1485
     end
     if cont_parada>1000
        parar=1;
1490
        x=zeros(30);
        y=zeros(30);
        for ponto=1:30
            x(ponto)=aptidao_ext(1,1,ponto);
1495
            y(ponto)=aptidao_ext(1,2,ponto);
        end
        plot(x,y,'r*')
        xlim([10000,19000]);
        ylim([0,custo_limite]);
1500
        xlabel('Water Footprint (1/kg)')
        ylabel('Transition Cost (R$)')
        grid on
        hold on
        saveas(gcf,'pareto.png')
1505
    end
     end
```

Annex

## ANNEX A – Climatic Data

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んな気	を変わ	55700	物意 机链	175	ろ塗わ	を
んわ	をあ	お	物意 机肠	knnb	ろ塗わ	6
htop	をわろ	わわつ ~	物意 机物	を゛	ろ塗わ	h
who	をん	初始	物镜 机	んわ	ろ塗わ	64
んめ	をうわ	ねっか	物颜 机毯	を	ろ塗わ	う
han	を塗ろ	bB≌b	物颜 物链	を剃び	ろ塗わ	ん塗
んわ	を恐ん	555	物动 机动	knob	ろ塗わ	を
<i>hi</i> bb	んねる	物怒	物动 物釉	あう	ろ塗わ	hà
wab	hes	ねあう	物动 物卷	をきき	ろ塗わ	3
んどう	んをを	ろ <b>塗</b> っ ゛	this the	knhij	ろ塗わ	を
hZh	んゆわ	相愛わ	物动 机乾	を塗ん	ろ塗わ	を
he	hao <sup>°</sup>	ろゆう	that that	hoat	ろ塗わ	<b>A</b>
んぼう	んねゑ	われるん	that thes	んるきわ	ろ塗わ	62
h 🛛 🕹	has have been a second	1340万	that that `	hond	ろ塗わ	62
hB	んのを	杨苍、	that the	を濁わ	ろ塗わ	h
んれづ	んぼわ	をおう	that the	あれる	ろ塗わ	う
Wat	んぼう	われ	this that	を愛う	ろ塗わ	んどき
んなた	んをつ	物震	thethe the	んわれづ	ろ塗わ	6
んねつ	んを、	动动	this this	んれぬを	ろきわ	6
han	hilada	わるん	this this	ED D'	ろきわ	h
h	hitu "	わわわ	this that	んれぬわ	ろ塗わ	64 6
をむう	hit	物を	this the	khate	ろ塗わ	ん選
を心	<i>h</i> ≱`	物额	this that	んわるわ	ろ塗わ	62

をゑ	んきあ	物动	机作物	කි	ろきわ	ん
をわ	he ``	根を	tha that	をあめ	ろきわ	じょ
をか	うる	动动	this the	んかわ	ろきわ	h k
をご	うれ <sup>、</sup>	わ335	this the	内石内石	ろぬわ	64
をうう	う通わ	ねるう	执机 机酸	をわ	ろぬわ	62
をうか	うぼう	杨凤	the the	ぢ	ろぬわ	う
を涼	うわ	な感	thite thin "	を濁わ	ろぬわ	る絵
をわ	うを	わえう	this this	knab	ろゐゐ	ん選
をわ	うわ	ねむ	机石机石	をきなっ	ろゐゐ	る絵
をう	うる	ねまう	that the	をおろ	ろ◎ゑ	h
をわ	うめ	反応	<b>オれぬ</b> わ ゎ 塗ゔ	をむわ	ろ◎ゑ	ジャ
を加え	うねっ	机图	われわ わ 塗を	んちれわ	ろ◎ゑ	を
をわ	う <b>が</b> を	反ち	<i>オれ</i> 43 ゎ≧わ	をおわ	ろ◎ゑ	うき
をわ	Эðð <sup>°</sup>	物を	オれん ゎ塗゙	を塗う	ろ絵を	ん選
をん	う通わ	をあ	拍を、わぶん	を遭り	ろ☆を	うき
をおう	うぼん	わを	物态 わう	をめ	ろ泣を	64
をあ	うを	杨震	物态 力 影	を認め	B≌ĥ	h
を認め	うきり	招類	机额 力道"	を遡り	B≌ĥ	んれ
を知	うるん	杨莲、	物态 力 遊	を予め	B≌ĥ	んき
を知っ	5%	ねっか	物をわれてい	を思わ	ろ塗う	3
をを	うどわ	物查	加密 わえ	をわ	ろ塗う	ん愛
を愛い	うるを	たわ	物象、わどん	あう	ろ塗う	う
を願	Э́м`	<b>按</b> 题 "	机动力的	を思わ	<b>3</b> 2 <sup>°°</sup>	3
を愛わ	うわ	抽查	机乾 力 密	ත්ත	<b>3</b> ☆``	を
を愛わ	うき	初知	相の わぼう	Knarb	わ	ん漫
を柔	<b>う</b> ず	われび	村の わ 瀬原	んれ震	わ	64
をおう	づわ	わわわわ	村園 わうわ	んれっろう	h⊉B	hæ
をか	うきね	わなわ	おんの わるの	んちまわ	わ わ B	ん選
を読え	うふん	扬机	these have	反対	わわわ	を変
をわ	*	<b>Ze</b> d <sup>°</sup>	おねる わぬわ	を反	われわ	<u>A</u>
をむわ	<b>塗わ</b>	ろろう	柏路 わる	ත්ත්	われ	<u>z</u> ł
をわ	*E	子的物品	わわり、わうを	んごを	われつ	<u>A</u>
をおう	Ľn`	ろい	われん われわ	hp柔	われる	<u>A</u>
をわ	<b>迷</b> わ	物を、	わね わめ	を濁わ	われる	んぼ
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কাকু	逐 う	初約	物かりがわ	る愛ご	わた	64
をわ	<b>B</b>	わきり	the two	んなた	われた	を
をわ	<b>i</b> an	ねあう	わわわわる	house	われん	64
をわ	3 an	わ335	わわわおどわ	るあ	われづ	ん選
をわ	йо	hoth	ねるん わる	んねきを	われづ	ん漫
をめう	<b>1</b> 200-	物感	机石の われん	杨祝	われ <sup>×</sup>	68
をおう	₫ <b>2</b> 00	ねかう	机石 力靴	を罰う	わる	ん
をか	Ш.	<b></b> 根施	<b>われ</b> ろ わ゛	KNAB	ねめ	ん
をえ	<b>資わ</b>	わゑ゛	机振 动流	host	わる	ん
を反	3 and the second	われた	わわわ かぶる	here	わざわ	を
をわ	۲	物を	ろうがが	を塗わ	わざわ	68
をわ	変わ	ろう	ろ激烈が読	る柔	わるわ	<u>A</u>
をわ	塗ん	tzze ~	ろ塗わがす	んれっちう	わるわ	6
をわ	×S	反物	3 හි තිහි	を習わ	わる気	h
をわ	1 2 3 3	からわ	ろ源が	をわわ	わるを	う道

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をわ	ي م	おかれわ	ろ 遊ら	かね	を感う	わるか	ん遊
をわ	塗わ	ろ <b>あ</b> う	ろうが	动场	3hab	わろう	<b>A</b>
をわ	<u></u> 塗を	ろきろん	ろ <b>必</b> ゐ	ත්රී	んわねわ	わる゛	<u>A</u>
をわ	گۇس°	ため	ろ 猶ろ	うる	ත්කුවි	わる゛	う
をわ	<b>塗わ</b>	おかわ	ろ 遂ん	があ	を運	わわ	62
をわ	۵. Sh	物產	ろ塗わ	がぼう	をうわ	わる	んぽ
をわ	<b>塗</b> ろ	物造、	ろ遂	が願	knab	わわ	h
をわ	<u>گ</u>	初纪	ろ瀬を	が塗り	khhö	わわ	h
をわ	<u>گ</u> و* * *	马动	ろ <b>塗</b> わ	がゐ゛	kning	わねる	<u>A</u>
をわ	zhab	ねむわ	ろゐ゛	かき	をきわ <sup>×</sup>	わた	h
をわ	zhan	ねめ	ろ資源	かぬり	を泣を	わた	う逐
をわ	子的名	物感	ろ 遊る	おね	を読	わわ	62
をわ	ろれるわ	<b>換</b> 密	ろうが	おわ	んれぬわ	わわう	ん遊
をわ	ろれてう	たわ	ろ むねつ	かね	を診を	わわ <sup>°</sup>	じょ
をわ	Shipp	かどう	ろわ	かめ	るよう	わわ <sup>゛</sup>	32
をわ	3nia	ters "	3 🖬	がめ	hondo	おあ	る
をわ	<b>Zh</b> ab <sup>°</sup>	the	ろうわ	かた	んゑ巻り	ねる	を
をわ	Shitob	わ	ろ 涵 ゛	がわ	hb	わわわ	64
をわ	zhaz	ねる	ろ遊を	かわ	をかる	われわ	ん達
をわ	znioj	70td	ろ <b>逐</b> わ	かる	kning	わね	を診
をわ	31035	ろきわ	ろ靴゛	方気	hpinz	わた	<u>z</u> a
をわ	zhad	ろ逐	ろ戦気	わぎわ	をあう	われを	を
を反	3hat	ねめ	ろ塗わ	1018	んわぶを	われ	を
を反	 31125	ろ 遊	ろごう	かれ	を゛	わめ	を
をか	3hæ	わる	50%	が原	を加め	120°	h
をか	zhab	なる	ろごわ	かわ	ක් කි		62 10
をおう	zhado	物级	555	10th	hpat	10000 10000	64 10
をわう	3n ar	をあ	50	かゆう	ත්වේ	わなわ	わる
をわ	3næ	お願わ	333b	が過き	んどう	わぼわ	を
をわ	引起	物名	351/u	かぶる	10-20	われわ	64 10
を わ	引起	动极	5%	かぶわ	khab "	わる	/⊶ /₩
をわ	3hæ	校を	ろうねわ	が塗い	ねる	12000 12000	ん <u>速</u>
をわ	3har	120000	35%U	からう	んなを	120000	/04 /04
<u>କ</u> ୋକ୍ଟ	zhad	杨蒙	5週	わめん	を勤	わるか	104 105
をか	3hab	1200	35360	加速	んわれわ	12-20 わむ	ん <u>逸</u>
をか	3has	杨	5385	かぶわ	んねき	1200 わむ	102 102
をめ	3 ndoj	物意	う) こう え`	かぶわ	70日本で を必めづ	1200 わむ <sup>×</sup>	104 102
をわ	3 mar	11200 1120	5)た	わぶ	hhab "	わえ	70歳
をむわ	31020	極為	50減h	the `	杨庭	われて われて 1250	3
をむわ	zhio *	ten h	5525	れんづ	をある	か <u>ま</u> ろ	ン4 ん途
をむ	3 nao	極う	තිබී	then	感知	わえわ	ん。 う
E Como	3 miles 3 miles	7220 塗を	5000	加級	313D	わえつ	力強
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<b>通</b> の を柔	3100 31030	- 1 40 わわう	5000°	がぬり	んかぼわ	わたの	biza hoža
を 変わ あ あ あ	3hm Zhinz	おかわ	55m	われわ	hten "	わた	ん <u>な</u> う逐
を あ	3ht/B	わかがわ +*	动物	松格	んわ <sup>会</sup> を た。	われた	
を願	込わ	17560°	ろわ	the the	を激わ	わえん track	
を動	<b>送</b> を	わ塗ね	5343 7=10-1	わぬ たいた、	<i>h3</i> ≌わ <i>≫</i> =∞/	わえん	う <b>ぶ</b> たわ
を釣	<b>i</b> ah	通る	Site	かを <sup>、</sup>	透明	わまう	われ

をを	遊 "	15 TE	නාංග හාණ	うわ	わえづ	<b>A</b>
を を を わ	遂	ے۔ کھ <sup>ر</sup>	ろうを がを `	うしまわ	お薬	われ
を通わ	je na se na	м <del>и</del> з		刻	わ気、	わき
をある	3D	动源	ろうわ かどう	杨杨	わゑ゛	3
をあ	₫ <b>D</b>	わか あ	ろうわ かぎ	んかあん	わを	をき
をもう	<b>2</b>	扬速	ろうわ かだう	KNAZ	わを	を
をわ	Ìn "	th	5318° 协造"	を鬱わ	わざろ	う過
をわ	うごう	<b>٤</b>	ろあう がを、	んむぼわ	ねる	わら
を検索	うを	芬透	53%h 抗產 "	んうれづ	わち	みき
をん	JAR	3nto "	5)随 机卷 "	ゔ゚゚゚゚ゎ゛	わおろ	わき
をう	う酒り	をあ	30000 机制	ん資	わち	hæ
をうわ	う漢	<u>S</u>	35% 机石	h 🛮	わをわ	<b>1</b> 65
をむ	うの	555	33366 机石	汤肠	わをわ	<u>A</u>
を気	うえ	ろきわ	55360 that	うわ	わるわ	みを
をうう	うるわ	ねふね	5336 かぬわ	んうわ	わるわ	<i>h</i> ∕≊
を診	ゔ	わろわわ	5380 that	んをわ	わるわ	を
をもう	んろうん	Zhûĥ	5380 M/m	后和西	わるわ	<u>A</u> ž
をゑ	んねる	ゎ゛	538わ かを	Knab	わきわ	<b>ご</b>
をふん	んあろ	ろ 瀬ね	5336h thuah	んわあん	わきわ	を図
をう	んゆう	物额	ろうるわ かんぶ	んむそう	わきわ	を
han	പ്രാ	ろかわ	5ාිනි භාන්	heto`	わきわ	みを
んわ	hand have been a second	わ h	53ක භානි	んたわら	わきわ	う適
hte	んれづ	3hh "	5万天 からわ	んんれわ	わち	わぬ
んわう	をきえ	ろを	5万天 机动	<i>h</i> 3∰ੈ	わざろ	<u>A</u>
んろ	をうわ	ろ透	ろきを かき	hhite	ねる	を
んるり	を <u>を</u> *	ろわう	තිබී හැකි	heate	わち	<b>75</b> 2
る際	を変を	ろめ	තිනි භාෂ්	子和	わち	われ
んそう	をわ	うあっ	35泌 が心わ	违	わを	わ塗
hte hte	をあ	33 D	ろうわわれどあ	JUR	わを	わる
んゆわ	をあ、	ねめ	ろうれる かぶを	んれる	わゑ゛	hite
んた	をわ	わたわ	තාන භාවි	を踏	わゑ゛	う
んわう	<u>A</u>	the solution	නිංක හි	んわきわ	わえづ	を
んわ	えどう	をき	Site toth	hpito	わえづ	ん塗
んわ	えんわ	机路	ろうが が原	රුණ	わるん	を
んた	灵を	わわわ	35% 15%	kháb	わるん	を塗
んちう	ād <sup>°</sup>	んわ	5313 153	ත්ත්	わまた	わる
hito	えわう	Shab `	ろわ かる	わわ	わまた	<b>7</b> 28
んぼわ	系加	35kh	动象动象	35Th	わた	<u>A</u>
WAR	ゑ密か	ろ ごうわ	තින් තිනි	ん゛	わえつ	<u>A</u>
んゆう	ゑれん	53mb	ろぬ 初始	杨海	わぼわ	<b>R</b>
んゑ	あきん	<i>ħ</i> 58°°	550ab 1570ab	んを してい	わえり	を選
んぼわ	あっか	3hæ	动脉动	うまだ	わえり	われ
high	Jale h	ප්රති	5000 100	选版	わまろ い デ	おね
んぼう	ねをう	わ ~~~~	ろう がわわ	を習り	わゑ	う
んをわ	dæ 19	ろわ	ろうわ わた	3n/13	わね゛	た <u>ふ</u>
hite	<b>み</b> え	わぬを	ろう かん かん	hondab	わわう	を必
んあん	79975 7440	おつむわ	ろうれ かぬわ	htelu `	わわう	を
hite Litte	みわ		ろを がた	hondab	わま	を調
んねつ	たままた ユッマナ	thes "	ろうきわ が源	hand	わまた	
where	み変を	<b>ろ ៉</b> ື່»ັ່ນ	ろきを かえり	和新	わねつ	

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んわう	みわ	ろわれる	ろを、方敵	うわって	わまる	ter a
んちわ	ЪB	う泣~~	5343 152	うる	われわ	わぶ
を意	わわ	zhn	5%ね 1分数	うふを	わる	われ
んうう	わきを	ろれ着わ	ろうれん わざう	558D	わね	われ
んぬわ	わんづ	35巻わ	ろううがれ	うれの	わわ う	わ差
んぬえ	わねろ	をわ	ろうわ が凝	hab	わわう	われ
んごう	わある	ろりねっ	ろう あかが いうしょう	うえ	われ	<b>7</b>
うわ	わえん	わぬ	ろうがかわ	ん <b>逐</b> ん	われを	を診
うわ	わゑ	机动	ろうわ わうか	うたを	われる	<b>A</b>
うれ	わるわ	13 <sup>3</sup> 3	ろうえ から	れき	われわ	を
うる	われ	招助	ろうう がえ	反応を	わわ	を整
うるわ	わめ	35mb	ろ 躙 がご	んどう	わる	<u>A</u>
うるん	わね	53	ろ靴ね わ靴わ	たきん	わわ <sup>゛</sup>	<u>A</u>
うわ	わろう	<i>わ</i> b⊠ `	ろうを われ	んねのう	わわう	を
うわ	わ逐わ	われわ	ろ靴、お邂逅	hoat	われ	62
うわ	わた	ねう	ろ遊りり遊ゑ	んわれる	わた	を整
うわ	<i>わ</i> ≌```	<b>276</b>	ろ 遼東 わ 邎 ゛	Jah "	わねる	わ逐
うわ	おわ	子的石品	ろ 遊う わ ぬわ	310	われわ	わ逐
うわ	わっか	ろいた	ろうわ わうか	hote	わわ	2
520	わらわ	 わむわ	ろ 塗わ わ 塗ろ	る瀬	1210 1210	を
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5266	1)102 1010	が変	ろう わる	んを塗わ	わめう	を 私
うえ うえ	わるわ	お弦	ろ靴のわ瀬の	んうきわ	わるを	を
うぼわ	わゑ゛	1月20	う 靴 わ 勤 ジ ろ 靴 わ わ 勤 ジ	10241) Materi	125C	を認
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う う う	わ <b>ろ</b> ろ	31033 ZEVES	ろ 激わ わ 塗わ	ん気わり	わわ	<b>A</b>
うぼわ	われ <sup>×</sup>	55355 75110 \	ろ 愛か わ 愛を	う <b>お</b> めう	わわわ	24 24
うずん	われた	Zen `	ろ 塗、 わ 塗、	动物	わ	
うう	われる	おなん	ろ 遊ろ わ 込み	hを柔	<u>ろ</u> 塗 <sup>**</sup>	6æ
うきわ	ろ塗ん	<b>ZAB</b>		んわれのう	ろ泣う	
ゔゎ	ろ塗わ	ත් <u>ති</u> වි	3 be that	を塗わ	ろ塗を	<i>h</i> ⁄≇
うきん	35)	ろりをわ	3 Son thing	<i>king</i> b	<u>ろ</u> 塗蒸	<u>مع</u>
うごう	ろ () ()	th	3 že thái	んれこう	ろきあ	<u>```</u>
M.	ろうわ	5)@b	3 m the	hhiteh	ろ塗わ	われ
<b>йл</b> ь	Ξ⁄ω Ň	を感じ	ろ 塗わ わ ある	<b>Ja</b> lah	ろ塗ろ	わえ
₹ E E	ろを	<u>ک</u>	3 m h h b i	うう <u>あ</u> わ	<u>S</u> ≙`	われ
₹2hu	ろわり	子的物	3 the three	うか	35	<u>A</u>
й́ю́	SAB	ろ願	ろう わわる	んどう	පත්	<b>A</b> A
3	ろをう	<b>JAR</b>	3 🗟 thuch	ん変換系	ろき	<u>A</u>
迷わ	3.25	ろを	3 333 the	る絵を	3 <b>क्र</b>	みる
逐わ	ろあわ	ろうわわ	ろ 資わ わねわ	うるわ	ろうわ	<b>J</b>
No.	ろをわ	ろんを	3 颜 加板	われづ	ろうわ	<u>A</u>
کی کی	ろを	ろ 資わ	ろうん われの	んぼう	ろうか	を通

逐 か	ろゑ <sup>*</sup>	5535	ろ 🔊 が わぬる	んうきん	333	
<b>迷</b> う	ろぼう	ろんち	3 🖄 hhab	るな	ろう	<u>A</u>
Ш́р	ろろん	ろ 遡わ	3 <sup>™</sup> b hnete	んわえう	Ξhu Ň	を
Ш́р	ろ変を	ねっきん	3    	んえぬわ	ろねづ	600
∛abb	3 <b>2</b> 2	子を	3 🚵 thes	うかろん	ろんを	758
塗わ	ろえつ	ろからろ	3 🖗 h thác hác hác hác hác hác hác hác hác hác	うかうづ	ろれを	みぼ
塗わ	ろえつ	ろ瀬原	ろ言う 初露	のた	Sha	を
) AR	ろえつ	ろきね	机机到	んを変わ	ろねる	<u>A</u>
≌n/u	ろえつ	ろわれわ	that the	うねん	ろわり	る社
≌n/u	ろえつ	ろきう	that the	んわまを	ろれわ	<u>A</u>
ಿದ್	ろえん	ろうか	物额 物码	わう	343	A
ಿದ್	3 <b>2</b> 0	ろわ	the the	うかえ	Shu	<b>A</b>
No.	320	ろりを	thtis thesi	33h °	3æ <sup>°</sup>	<b>7</b> 21
NO.	3	をわ	that the	100 Marin	350	h
∛cp	ろを	动怒	<b>扮怒 わ</b> ろ	和路	350	<u>A</u>
*Ch	 ろ変を	<b>王</b> 子	the that	うを	 3360	<u>z</u>
<u></u> 踏わ	<u></u> ろゑん	<u>柔</u> の	机动机级	3040	3.85	われ
<b>連わ</b>	3 <b>2</b> 5	3033	these thus	hita	325	A CONTRACTOR
No.	Jan Jan `	53	物路 机药	1515 1515	38	を建
**** ***	<u>ろを</u>	反都の	机砂 机心	を塗	330	64 10
**** ***	383	5	おあ、わる おあ、わる	を塗り	335	702 28
±200	- <u>う</u> こう - ろをわ	153°	these these	んかき	うる。 ろきわ	を必
<u>ネ</u> の	- <u>5</u> をわ	10180 ろわわ	11 and 11 and 1	hhito `	う 3 潜わ	231 731
<u>ネ</u> の 塗の	5.20	5040	相助 抽题	hđa	- <u>5</u> をわ	0.34 A
*20J 淡わ	- 3200 - 3200	动观察	机路 机链	れる んねふぼわ	ටතා ටතා	を感
360 370				71220) 31/200	3æ3	
		<b>30</b> 200	the the	-		73% +04
	525 775	数 で か て い な の を 、 、 、 、 、 、 、 、 、 、 、 、 、	the the	われた	383	われ ユッ
	ろを <sup>*</sup>	ろかる		づかわ ですい、	ろを	738 1-1
	510 747	AD LAT	the these	Š∕á` ≈≈∞	ろを	われ
No.	343	10000 7. 1173	these there	558h	ろを 73 ×	わき
No.	ろんわ	ろりを気	this the	33/43	<b>3</b> ゑ゛	
Ĩabu Na − N	ろね	を知っ	that the	ねの	ろゑ゛ ファ゛	われ
	542 	わるわ	わぬ わえ	わる	ろ柔 <sup>×</sup>	31
а Забо	ろを	んねう	the the	ちめ	ろ柔 <sup>*</sup>	わえ
₩ ۲	Sah	<b>33</b> 10	these they	うきも	3 <b>2</b> 0	わき
資わ ) )	ろねう	ろりおう	われん わゆう	动物	3 <b>2</b> 0	75 <b>1</b>
資わ )	3/w	55°50	おねの われい	を図り	3 <b>2</b> 0	を
濁わ	ろう	杨路	物物作物	රුණා	ろぼう	624
<b>塗わ</b>	333	う <sup>注</sup>	机面 招	んむむち	ろぼう	わる
<b>A</b>	Sob	ろきを	机路 招格	化的	3 <b>2</b> 0	<u>A</u>
塗ん	ろわ	50 m	that tank	予約	රුවර	<b>A</b> CG
塗	ろうわ	ろわり	that hand	35th	3 <b>2</b> 3	205
愛 ゔ	ろ涼	ろわれん	that total	うかわ	ろぼう	254
۲ ک	ろを	动怒	that the	んた	ろぼう	<b>7</b> 2
遊	ろうか	ろ 戦気	thus the	施扬	ろぼう	を
遊	පත්	3 ibb	the three	hat	ろぼう	を
通わ	3D `	ろうろ	the three	んぼう	ろぼう	<u>A</u>
塗わ	3ª	わる	the total	んぼう	ろぼう	を
通わ	ろぬろ	ゐ	the total	うぼう	ろぼう	34
<b>塗</b> わ	ろ☆わ	わる	than tothi	无品	ろゑ゛	を

<b>遂</b> わ	ろきわ	ろうな	the	招拓	んごを	Sæ <sup>°</sup>	<u>A</u>
<b>透</b> わ	ろ☆ゑ	ろんろう	わむ	招机 "	んむごわ	52 °	<u>A</u>
<b>遂</b> わ	ろきを	ろがを	わるう	扬图	んを変わ	S₹ <sup>°</sup>	<u>A</u>
塗り	ろ給ん	ろ、願	tha "	扬图	ん <b>ジ</b> ab	S₹.	え
塗り	<b>5</b> ¢``	うを	tha "	扬跖	うれる	ろを	われ
塗わ	わ	かわ	tha "	扬弼	んをねる	ろを	5
塗わ	われわ	机机	拍氣	招習わ	ින්ති	ろを	ね
塗わ	われわ	ね	拍氣	招習わ	を塗ね	333	يني ا
塗り	われた	ろいうわ	拍氣	おわ	That	383	えば
塗わ	われん	ろうわわ	机配	ねるわ	うえい	333	758
塗わ	われ <sup>×</sup>	53è	机貂	招勁	6 <b>E</b> h	ろきわ	を
塗わ	わるの	ろの東	机貂	招勁	ん猶乏	ろきわ	ත්ර
遊	わるり	马旋	物類	扬骤	んどう	ろきり	<b>7</b>
遊	わる	わきを	物類	扬骤	んれる	ろきわ	ん逐
愛 ゔ	わろん	ろ验わ	物類	扬骤	3N/13	ろあわ	7
愛わ	わわ	3has	わぼり	扬链	ට්රාවිට	ろあわ	わき
Ĭ₩.	わわわ	5€•n°	物類	扬楚	わわ	ろあわ	<u>z</u>
Ĭ₩.	われえ	33 M	物類	扬劭	うまで	3 to 2	わら
塗り	わわう	33 M	物類	扬劭	うまで	3 to 2	わら

І ІҲҴ҈от	± ∱= "ሰቬ "ሰጅነ በ"⊐ T\/	ulenti tin TV	<del>мт Т ;</del>	1 kk/ PN I	T&L-	<sup>1</sup> т%ифбЦрт	Э↑Џіӿ҄Ҟӷ҅ЩҬіҳӷ҄Цҧ҃ЫХ			
{ IX/3	t∱тд©шийрШйыХ	ѡЦѻ(ЦҋӸҲ	×I 1 1X	ी <b>॑Ц</b> ∱्षीЦ	- Іфіцрт	oIX'⊤∐‡IX	от wтытîх ЩоЩ			
ⅅⅎℷ℄ℾ	ΙI	aW⊌I⊅ôô0LL	а⊄ши∕	аЦ≒и∕і	Ξ	I	ΙI			
愛わ	わるんえ	ろきねる	ත්ත්	揺れ	んれまう	ろきを	<b>A</b>			
溪	われた	わえる	ත්ත්	ಶಿಖಿಾಶಿ	るる	ろきを	を			
3 and the second	われえ	相密	b5ab`	招給わ	ん猶ろ	ろあん	を			
W.S.	わた気	3 🕅	b5ab`	招給わ	ん資源	ろをう	を			
3 <b>1</b> 0	われえ	No.	b5t⊅ `	移が	れの	ろをう	われ			
with the second second	われ気	5 kg	杨	移わ	hter	ろをう	を			
<b>塗</b> の	われた	55735	杨	移わ	んねまう	ろを <sup>、</sup>	を			
₹ <b>2</b> 6	われた	ろもで	杨杨	移動	うわわ	ろを <sup>、</sup>	<u>A</u>			
<b>塗わ</b>	われる	ろ <b>津</b> 6	杨杨	招給	hh	3h	を			
∛c⊅	わるう気	5085	杨杨	拯ゐ	うかわ	Sho	み進			
<b>塗</b> の	われた	颈旋	わろわわ	拯ゐ	horad	Sho	<u>A</u>			
No.	われた	55m °	杨わ	招給	hphu	ろれわ	を			
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	わるため	thti	おわ	招激剤	化验	ろれわ	を			
Ů <b>°</b> 0	わる気気	机疮	杨杨	秘索	脑癜	ろわわ	を			
選	拖克	ろ遊気	杨杨	招演	んを塗を	ろわわ	を			
<b>逐</b> わ	われる	打场	招校	招演	んわれわ	ろね	を			
×	われえ	<b>ठ</b> केंद्र	杨颓	極点	ん塗ん	ろね	を			
¥16	わず気	んろう	杨乾	掻漉	うた	Sha	われ			
塗わ	わうえ	ねぬろ	扬机	招演	Br (	ろれを	を			
*	抱猿	おれる	扬机	秘索	化物	ろれを	を整			
うふん	虚気	ろんわわ	おめ	搔魚	うちをわ	ろんを	<b>A</b>			
うわ	加坡	ねめ	おめ	ねき	んを図り	Shh	を			
うど	加速	物额	<i>わ</i> 540 °	ねぬを	htplu `	ろんづ	を			
うわ	わるため	おれるう	杨ゐ	ねき	hpEh	ろんづ	を			
うぎわ	ねるゑ	55 mb	hB1B	招激	んねまう	<b>3</b> h <sup>°</sup>	を			
うぼ	われた	thes	hBBB	招激	৸ঠাক	- Shu	を			
うれん	力如何反	ろを	h50ch	招激	わあん	<b>3</b> h <sup>°</sup>	を			
うどわ	な気	ろき	わびわ	搔ゑ	をごわ	පත	を			
うん	わる	おんわ	おぼわ	招激	knaz	333	62			
うるん	わるかえ	ろ <b>塗</b> わ	handhan	招激	んちょう	333	を			
う酒り	われた	ろうの	杨振	招激	んれまう	333	を			
うぼう	わたえ	ろわ	招陸	拯る	hBhB	ろうわ	を			
う願い	わるため	this	招陸	超ゐ	んえわ	ろうわ	を進			
うぼわ	初期	ろうね	わろわか	超ゐ	う ふ わ	ろうわ	を			
うぼう	わる	the	hBho	超ゐ	んをねる	ろうわ	を選			
5000	わがえ	ねぬろ	わわう	超が	る念を	ろうわ	を			
うぼわ	わらう気	杨荣	hBabû `	超わ	んねねる	ろうわ	る通			
うめ	ね縁	ねむ	招麗	わろ☆わ	hote	ろうわ	h			
うた	Date Ba	ろう	招麗	招給わ	んうぼわ	3. The	を			
うわ	动物系	わる	招紹	招給ろ	をあわ	ろうえ	る絵			
うめ	DE CON	杨杨	お願わ	招給ろ	んれう	ろを	を			
うえ	and	子和西	お願わ	杨	うちょう	ろを	<u>A</u>			
うわ	みれた	わぬ <sup>、</sup>	お願わ	杨	ねろろう	ろを	64			
うろう	动物系	わわう	お願わ	扬う゛	んわれる	ろを	ん			
うえ	みまた	わち	招致	ねう	んろ塗わ	3 Sh	<i>h</i> a			
うきわ	みはを見	わえづ	招願	ねう	hand	3 Sh	を			

うで	る意気	扬速	招麗 招勁	hBhB	ろうづ	ん塗
うた	るを見	おむわ	招乾 招焚	hto	ろうづ	を塗
うわ	るをかえ	ත්ති	招聽 招頭	hをね゛	ろうづ	h
んゆう	るはた	ろかわ	招乾 招劾	うわめ	පත්	<u>A</u>
んぬえ	astre	ろれ気	おいわれるわ	heni	පත්	る道
ん塗わ	みうかえ	わち	杨飘 扬动	を巡か	ろう゛	んぼ
රුණ	る意	物願	ත්වේ තියි	を加え	ろう゛	h
ht	AND	おねる	ත්වේ තීම	われる	<b>3</b> 5) <sup>*</sup>	ん選
んぼう	AND	わを	扬动扬机	んわれる	<b>3</b> 5) <sup>*</sup>	62
んち	A TAK	ろわ	招配 招応	33Sh	<b>3</b> 5) *	<u>A</u>
when	রার	われ	招惠、招加	んを図わ	<b>Š</b> ≙`	64 6
んねゑ	র্ধান্ত	おね	招魚、招格	杨祝	<b>3</b> ≙`	を診
んねわ	ゑわんゑ	颈旋	招惠、招加	んねぼう	<b>Š</b> ≙`	<u>A</u>
んをう	ALLA	杨韵	超魚、招加	KDAD	<b>Š</b> ≙`	ん選
んあん	A BEE	3 <sup>°</sup>	招魚、招加	んまわう	<b>S</b> ☆`	を
んをわ	A DE DE	わる	招连招乱	を挙び	ろ塗ろ	61 A
んをわ	2000	ろ漢゛	招登 招登"	んを変わ	 ろ塗ろ	を
んぽう	ALTA	お習り	杨善扬为	hande	 ろ塗ろ	を建
hãh	AND	the "	おを おきを	んむきわ	 ろ塗ろ	を強
んぼわ	<u>a</u> ta	物版	おき おあ	んるをわ	ろ塗ろ	を
ん愛わ	<u>z</u>	相図り	おを おをわ	horan	<u>ユニ</u> ン ろ塗ろ	を整
NAD	<b>2</b>	ねむを	125 1251 126 1261	加超	<u>」</u> ろ塗ろ	し、 ん逸
hitte	を加速	1380	超差 招震 "	んぼう	<u>ス</u> ろ塗ろ	を選
10250 10255	24 CM	おぶろ	超差 招致	hhite	<u>ス</u> 塗ろ	64 10
hab	をかえ	杨柔	超差 扬蕤	を知る	<u>ス</u> ろ塗ろ	通
hites	をかえ	杨扬	おを お歌	hnzh	<u>ス</u> ろ塗ろ	<u>ス</u> 逐
1405 NAOS	<u></u>	杨堂	お柔 おかわ	ん気をし	<u>ス</u> 塗ろ	 ん選
1.4000 1.4000	を対象	332	1200 1200 1200 1200	hatos	<u>」</u> ろ塗わ	- 「 を選
640	E A A	わ	1200 1200	knab	⊅ ろ≌わ	6.18
http:	を致え	杨物	杨柔 杨雄	/a <b>₽</b> 00 を`	 3≌わ	ん <u>逸</u>
hato	を を	初超	招柔 招助	htp	 3≌わ	6.4 6.4
/ ୩୩୦୦୦୦୦୦୦୦୦୦୦୦୦୦୦୦୦୦୦୦୦୦୦୦୦୦୦୦୦୦୦୦୦୦୦	を加え	132000	12000000000000000000000000000000000000	を	 3≌わ	が 通
han h	を加え	12000	1200 1200	を塗む	⊅ ろ≌わ	64
んわ	2010 1010	555	1200 1200 1310 1310	hh sh	ろ塗わ	70年 を図
1040b	刻加	加奶	1200 1200 1200 1200	あっ	ろ塗わ	3
hito	<u></u> 秘教	ねある	1222 1212	を を を	ろ塗わ	逐
んぼう	心和反	1 3 む い	10-10-10-10 15をう わかわ	Antro	ろ塗わ	を認
ん遥ん	んれえ	り 和 わぽわ	1222 1221	を塗ん	ろ塗わ	を認
10270 10250	hor the second s	引きる	杨秋杨秋	ht and a h	ろ塗わ	を建
ん <u>恐</u> わ	NER	加盛し	超数 超级	ん <u>お</u> 透わ	ろ塗わ	64
/034j2 ん澄わ	んむれた	13/200	12000 12000	んわれる	ろ塗わ	104 104
hes hes	的感	杨莲	超数 超级	を激わ	ろ塗わ	。 、 、 、 、 、 、 、 、 、 、 、 、 、
んむ	64000	極初	お乾 招勤	をかれる	ろ塗わ	33
10400 10410	NEDE	ねん	お乾 招変	を 愛	ろうわ	hil
104110 104110	100000 1000 ゑ	初風、	お乾 招勤	2 20 http	ろいわ	/04 んど
んむわ	NEE	初始	10年210月	が過を	ろいわ	10 <u>2</u>
ん 御 り	NE	ねる心	1022 1000 1322 131	ta Be	ろか	
h b	NEE	1100000 わり塗わ	お願 招を	んれぬわ	ろうわ	
をう	WATE	初遊	招致 招加	hne	ろれて	/04 /04
感し	ん地を見	初级	1040 1040 1320 1310	/10 0000 んわ透わ	ろいわ	- 10編 - 小道
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をえ	hote	物动	招露的 机浴	කුණ	ろかわ	うき
をわ	んで変換	ねを	招願り われを	をぬめ	ろきわ	ジェ
をもう	ん塗れる	动动	招愛り われる	んわわ	ろきわ	he
をい	ん塗蒸	わ335	招楽り われる	hBhB	ろぬわ	んな
をうう	గుజ్`శ్లే	ねるう	招露 物写"	をごわ	ろゐ	る絵
をうか	JAR	極級	招魚加發	ぢ	ろゐゐ	う
を気	JA DE	なる	招魚わり	を濁ゐ	ろぬわ	うれ
をわ	う で た 点	わえづ	杨尚、杨弼	khab	ろぬわ	ん達
をわ	<u> 3</u> 868	ねをわ	招訪 ねらう	をきわ	ろぬわ	ジェ
をう	动痕	ねまう	招助 机短	をある	ろ◎ゑ	う
をん	JUNE	根約	han that	をかわ	ろ◎ゑ	58
を加え	うかえ	机路	招睦 机	んちわわ	ろ◎ゑ	を
をわ	JUDE	反応	招级机	をきわ	ろ◎ゑ	ジョ
をわ	300	物を	招助 机药	を塗び	ろふを	ん進
をん	うわえ	ねめ	招助 加多	をある	ろ絵を	3
をおう	377	わを	招話われこ	をめ	ろ絵を	6
をあ	3000	杨盈、	招助机额	<u>そ</u> え な ふ	 ろ塗 <b>ん</b>	34
を読み	うねえ	招额	超わ、加助	を遡り	ろ塗ん	6×
を通わ	う で 気候 C	杨莲	134の わえ	を記	<u>ろ</u> 塗ん	ん <u>塗</u>
をわ	326	ねっか	ble that	e 動	ろふう	、 、 、 、 、 、 、 、 、 、 、 、 、 、
をを	<u>کھی</u>	物を	超短 物动	තිම	 3≙う	6.2 6.2
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を願	道点	1756U <sup>°</sup>	ろ勤め	わえる	を濁わ	われ	62 
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<ul></ul>	をを	NAME OF THE OWNER OF	おを	3 mb	ある	うねり	わまう	<b>A</b>
磁振         社が振         分加         けが振         分加         けが振         ウ強           電話         であた         けが振         73%         けが振         73%         であた	をわ	WEER.	ٽ <b>م</b> ٽُ	3 °	かぬり	うんれ	わゑ゛	わる
	を塗り	NOTE:	Mag Name	532	かぬわ	汤奶	わゑ゛	わる
報告:         新伝集         行き葉         53%         17%         ATWAG         19差         15%           さかか         う葉葉         11         25%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17%         17% <td>を認え</td> <td>NOTE:</td> <td>方類</td> <td>ろごん</td> <td>かぬわ</td> <td>的感</td> <td>わゑ゛</td> <td>ジ</td>	を認え	NOTE:	方類	ろごん	かぬわ	的感	わゑ゛	ジ
新加         当該         打加         当該         打加         当該         支前         打加         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         カ         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力         力 <th< td=""><td>をあ</td><td>WEER</td><td>わる</td><td>ろうを</td><td>わるわ</td><td>んわまん</td><td>わを</td><td>を</td></th<>	をあ	WEER	わる	ろうを	わるわ	んわまん	わを	を
熱却         ご読み、         記表         ご加力         け加力         化加力         化加力         行加力         行加力 <td>をおう</td> <td>A BAR</td> <td>扬楚</td> <td>ろうね</td> <td>わるわ</td> <td><i>khk</i>z</td> <td>わを</td> <td>を塗</td>	をおう	A BAR	扬楚	ろうね	わるわ	<i>khk</i> z	わを	を塗
新成         づ岐泉         空空味         ごうふち         けごねっ         ごうあ         けあち         けあ           香坊         うどあ、         オね、         ろうう、         けごねっ         ろうう、         けあた         けね           香坊         うはあ、         ろうう、         けごねっ         ろうう、         けごねっ         小         あ         けあた         けね           香坊         うはあ、         ろうう、         ひごう、         ひごう、         ひごう、         ひざっ         ひざっ         かあ         けあっ         みる           香坊         うはあ、         ろうう、         ひごう、         ひごう、         ひがん         小         あ         みる           香坊         ハゴス、         パゴス、         ガゴス、         ハゴス、         ハゴス、         ハゴス、         ハゴス 、         ハゴ	をわ	うえ	th	ろうわ	かぬり	を塗わ	わち	う
金融の              つきまま、             れため、             ろうか、             けのか、             ろうか、             かかか、             ろうか、             かかか             ス	をわ	Joja A	<u>ش</u> م	ろうわ	かぬり	んむぼわ	わち	わぬ
各部         うめえ、         けみはえ、         57%         けうねめ、         ウス         ウス           各部         うさなみ、         575         けうみみ、         575         けうみみん         575         けうみみん         575         けうみみん         575         けうみみん         575         けうみん         575         けうみん         575         けうみん         575         けうみん         575	を検索	うる	马走	ろうろ	かぬり	んうもう	わち	75K
部功         づけ返泉         万克         万万万         万万克         八百九         小百九         八百九         八百         八百         八百         八百         八百         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1 <th1< th=""> <th1< th=""> <th1< th=""></th1<></th1<></th1<>	をわ	5×50	Shib "	50	かめ	ゔ゚゚゚ゎ゛	わざろ	われ
<ul> <li>              かけのまた、 250°、 2500°、 1700年、 75440             があた、 2500°、 25040             があか、 2500°、 1700年、 75440</li>             があか、 2500°、 1700年、 75340             があか、 2500°、 1700年、 75340             があか、 2500°、 1700年、 75340             があか、 2500°、 1700年、 75340             があか、 7500°、 1700年、 75340             があか、 7500°、 1700年、 75340             があか、 7500°、 1700年、 75340             があか、 7500°、 1700年、 75340             があか、 75340             があか             があか、 75340             があか、 75340             があか             があか <li>7500</li>             がかか             があか             があか             があか             があか             があか <li>7500</li> <li>7500</li>             があか             があか             があか <li>7500</li>             があか             があか             があか             があか             があか <li>7500</li>             があか             があか             があか             があか             があか             があか             があか             があ             があか             があか             があか             があか             があか<td>をづ</td><td>うるえ</td><td>たた</td><td>53è</td><td>かる</td><td>ん資</td><td>わち</td><td>6</td></ul>	をづ	うるえ	たた	53è	かる	ん資	わち	6
管惑、 つどろ、 ろ気数。 5755 けつ進た うえれか、 けあか、 みま         の通知、 行きか、 行きか、 行うか、 けつあか、 けつあか、 けのあか、 みま         の通知、 行きか、 行きか、 けつあか、 けつあか、 けのあか、 みま         の通知、 行きか、 けっか、 けのあか、 けのあか、 けのあか、 かま         人は           をか、 んは、次、 けんは、 ひか、 けのあか、 けのあか、 ためま         ためまか、 たかん、 ろうか、 けつあか、 けのあか、 ためまか、 ひあか、 ためまか、 うま         たいまか、 たかか、 たかか、 たかか、 たかか、 けのあか、 ためまか、 うま         たいまか、 たかか、 たかか、 たかか、 たかか、 たかか、 たかか、 たかか、 た	をうわ	51000	<u>S</u>	555	to the	h 🛮 h	わをわ	ත්
を訂         人は、茶         れははあ         SDED         れびあい         人が置かい         小海           を注         人は日気         子山ん         SDED         れびあい         パブあい         パブあい         パガあい         パガあい </td <td>をわ</td> <td>JULE</td> <td>555</td> <td>ろうう</td> <td>方源</td> <td>33/13</td> <td>わをわ</td> <td><u>A</u>ž</td>	をわ	JULE	555	ろうう	方源	33/13	わをわ	<u>A</u> ž
香ご         小豆菜         甘香和         ろびみ         けびあご         小葱和         ウ酸和         交通           香心         小胡菜         子山山         ろびみ         けびあ         小胡菜         ウ酸和         交通           香菜         小胡菜         ウ         ろびみ         けびあ         パ胡菜         けがあ         ヴ酸カ         交通           香菜         小胡菜         ウ         ろびみ         けびあ         パカ菜         パカ菜         パカ菜         ウ酸カ         受望           香酒         小胡菜         ウ         ろびみ         ひびあ         パカ菜         パカ菜         ウ酸カ         受望           「いお菜         パカ菜         オカ菜         ろびろ         けびあ         パカ菜         ウ酸カ         受望           「いお菜         オカ菜         ろびろ         ひびあ         パカ菜         カカ         ジジ           「いお菜         オカ菜         ろびろ         ひびあ         パカ菜         パカ菜         ジジ           「いお菜         うごろ         うびぎ         ひびあ         パカ菜         パカ菜         ジジ         ジジ           「いお菜         うごろ         うびき         ひびき         うごろ         ジジ         ジジ         ジジ         ジジ           「いお菜         うごろ         うびあ         うびき         ごろ         ジジ<	を気	JEER.	ろわ	ろうう	かを	うねわ	わをわ	みた
密約         八雄东         子仙柏         芬野山         大方路         八雄振         内容         発展           密泉         八雄原         b         芬野山         竹茂属         村田島         ウ容         交換         村田島         ウ容           宮山         八雄原         古田原         子野山         行茂属         村田島         ウ容         村田島         ウ容           福田         白田原         子野山         方野町         村田島         竹香田         香倉           福田         白田原         子田山         子野町         村田島         竹香田         香倉           福田         白田原         子田山         子野町         村田島         竹香田         香倉           福田         白田原         子田山         子野町         村田島         村田         子営           小都田         村田         子野町         古田島         竹香田         ウ湾         う湾           小都田         白田         子野町         子野町         け西田         白田         ウ湾         う湾           小都田         香田原         子野町         子野町         古田         日田         白田         日田         白田         日田         日田 </td <td>をうう</td> <td>గుజ్`శ్ల</td> <td>ねふゐ</td> <td>ろうう</td> <td>かる</td> <td>んうわ</td> <td>わをわ</td> <td>6</td>	をうう	గుజ్`శ్ల	ねふゐ	ろうう	かる	んうわ	わをわ	6
密点         小樹菜         カ         375人         175果         八和花島         1925         324           宮山         小胡菜         3125         375人         175米         八和花島         1925         324           宮山         小胡菜         3125         375人         175米         八加茶         1925         324           福口         小胡菜         111 葉         375万         175%         小田茶         1925         344           小村口         小山菜         111 至35万         175%         小田茶         小田茶         344           小村口         小山菜         111         3755         175%         小田菜         1925         14           小村口         小村菜         11         3755         175%         小田菜         1925         12           小村口         515         575%         175%         175%         175%         14         12           小村口         515         575%         175%         175%         175%         14         12           小村口         515         175%         175%         175%         175%         12         12           小村口         516         575%         175%         175%         175%         12	を診	んの意思	わろわわ	55m	わる	んをわ	わをわ	を
密約         小銀板         3 號為         375%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175%         175% <th1< td=""><td>をむ</td><td>ん社会</td><td>ろかeh</td><td>55m</td><td>Юða <sup>°</sup></td><td>ん変わ</td><td>わをわ</td><td><u>A</u></td></th1<>	をむ	ん社会	ろかeh	55m	Юða <sup>°</sup>	ん変わ	わをわ	<u>A</u>
密门         人材放展、         打水根、         万万万         万万万         八万万万         人场东、         大大市、         石田         전量         DE         DE         DE	をゑ	ん遊気	ゎ゛	ろうか	が運	knarb	わるわ	う迷
(Atho         (Atho <t< td=""><td>をふん</td><td>んなれた</td><td>ろ 瀬ね</td><td>55m</td><td>が影</td><td>わあん</td><td>わをわ</td><td>を</td></t<>	をふん	んなれた	ろ 瀬ね	55m	が影	わあん	わをわ	を
(材わ)         (材和, 新和, 芬節方, 古万麗, 小和和, 均都方, 竹花,         (力和, 空花, 子和, 5万万, 古万麗, 小和本, 小和方, 小和本, 小花,         (力本, 空花, 子和, 5万万, 古万麗, 小和本, 小花方, 日本, 小和本, 小花方, 石融, 小花方, 日本, 小和, 小花, 日本, 二,	をう	んねえ	物源	ろうか	が濁り	んむぼう	わをわ	を
Anth         香油菜         子há         子ゴブ         计ブ酸         Anth         ウガジ         けガ酸         Anth         ウガジ         けガ酸         Anth         ウガジ         ウガ         ウガジ         ウガ	han b	when	ろかわ	ろうう	かえ	heto "	わをわ	みた
小花じ         香菇菜         芬菜菜         芬丁節         计方距         小花         <	んねわ	んれた	th 1	ろうう	が願	চিক্লাচ	わをわ	うえ
小酒         杏萝克         万速         万速         小酒         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·<	htthe	を読	3h/u <sup>°</sup>	555	方置し	んたわ	わち	わぬ
Math         苔癬菜         子奶萝         分沙>         行为         // 法         小麦         小点	んわび	を変	ふた	555	わぼう	んるふわ	わち	<u>A</u>
小麥         杏椒菜         Chán         方瀬市         大海市         大津         大排         ブボ         ブボ <t< td=""><td>hB</td><td>を変え</td><td>ろき</td><td>53è</td><td>かを</td><td>kning</td><td>わざろ</td><td>を</td></t<>	hB	を変え	ろき	53è	かを	kning	わざろ	を
小酒         古酒         古酒         古酒         古酒         古酒         古酒         古酒         古酒           小酒         香菇小菜         石油         万油         方油素         古酒         小酒         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·	んぼわ	を変象	ろわう	5333	かわ	hente	わざろ	252
Aub         香奶菜         芬油         芬油         力酒         力酒         力酒         小酒         白菜         小酒           Aub         香甜菜         け菜ご         芬油菜         方油菜         方油、         Aub菜         白菜         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         ·         · <td< td=""><td>he</td><td>を加え</td><td>ろめ</td><td>ろうわ</td><td>かる</td><td><u>38</u></td><td>わち</td><td>わふ</td></td<>	he	を加え	ろめ	ろうわ	かる	<u>38</u>	わち	わふ
Auth     谷田菜     村菜     万葉     万葉     内酒       Auto     英雄菜     村本町     万沙木     万沙木     万沙木     万沙木     万沙木       Auto     英雄菜     村田田     万沙方     万沙木     万沙木     石田方     万葉       Auto     英雄菜     村田田     万沙方     万沙木     石田方     日菜     万葉       Auto     英雄菜     古香香香     5     万沙花     Auto     日菜     日菜       Auto     英雄菜     古香香香     5     1万沙花     Auto     日菜     日菜       Auto     英雄菜     古香香     1万沙花     Auto     日菜     日菜     日菜       Auto     英雄菜     古田方     古沙花     日菜     日菜     日菜     日菜       Auto     英雄菜     古田方     古香香     日前花     日菜     日菜     日菜       Auto     英雄菜     古田方     古香香     日前花     日菜     日菜     日菜       Auto     古香菜     古香菜     日前菜     日菜     日菜     日菜   <	んぞう	を加え	うあっ	ろうわ	かを	逄	わを	われ
小桃菜       菜桃菜、       竹椒杏       芬沁小       竹沙山       杏葱杏       竹菜       ブ湖         小椒方       菜葱菜、       北白石       芬沁方       竹沙山       小小杏       か菜方       杏菜         小椒方       菜葱菜、       北白石       芬沁方       竹沙山       小小杏       か菜方       杏菜         小椒方       菜葱菜、       北白石       芬沁方       竹沙山       小葱方       小菜方       杏菜         小椒方       菜葱菜、       北白石       芬沁方       竹沙山       小菜方       カ菜方       杏菜         小椒方       菜葱菜、       北白石       芬沁方       小酒方       小酒方       小菜方       香菜         小椒方       菜葱菜、       北山市       ろ沙山方       方沙山       小菜方       白菜       小菜       香菜         小椒方       菜和菜菜       小山方       ろ沙山       ろ沙山       ろ沙山       小菜       白菜       白菜         小山方       菜和菜菜       ろ沙山       ろ小山       ろ沙山       小菜       白菜       白菜       白菜         小山方       菜和菜菜       ろ沙山       ろ小山       ろ沙山       白菜       白菜       白菜       白菜         小山方       白油       ろ沙山       ろ沙山       ろ沙山       白菜       白菜       白菜       白菜         小山菜       白菜菜       白沙山	hảo	を習んゑ	33 D	ろうね	かもう	John State	わを	わら
ハルジ     泉浜安     井和田     53 ジ     打加山     月加払     月加払     月加払       ハカ     泉焼泉     村倉佐     5<	んわ	<b>E</b>	ねぎ	ろうえ	おん	hhim	わゑ゛	ん
Abb       熟花菜       技施を       ろ、       力逆を       Abb       力数       分数	have	ゑれゑ	かをわ	ろうわ	われわ	をわ	わゑ゛	58
小松口       菜菜菜       村和山       5 靴口       竹道山       小石野ジ       竹類小       台類小       台類小         小松豆       菜椒豆菜       村和山       5 靴口       竹豆花       村方古       村菜小       小菜       村菜         小松口       菜椒豆菜       小松口       5 靴口       打豆花       小菜口       村菜       村菜       村菜         小松口       菜椒豆菜       小松口       5 靴口       竹豆花       ガ豆花       竹菜       村菜         小松口       菜椒豆菜       台山       5 靴口       竹豆花       ガ豆花       竹菜       村菜         小松口       菜椒豆菜       台山       5 靴口       ジ豆花       ブ菜       ガ酸       ガ酸       小菜         小松口       菜都豆菜       5 靴口       5 靴口       ブゴご       ガ酸       ガ酸       ブ酸       ガ酸         小松口       菜都豆菜       5 靴口       5 靴口       ブゴご       小菜       ガ酸D       ブ酸         小板口       西甜菜       ガ豆ご       5 靴口       ブ油       小菜       ガ酸D       ブ酸         小板口       西甜菜       ブ油       ブ酸       ブ油       ガ酸D       ブ酸       ブ酸       ブ酸         小板口       西甜菜       ブ油       ブ酸       ブ油       ブ酸       ブ酸       ブ酸       ブ酸         小菜口 <t< td=""><td>んわう</td><td><u>A</u></td><td>机图</td><td></td><td>ある</td><td>んわきわ</td><td>わえづ</td><td>を</td></t<>	んわう	<u>A</u>	机图		ある	んわきわ	わえづ	を
小板菜       菜酸菜       竹油的       5 靴板       竹萝芬       小和教       竹菜方       小和教       小桃         小板方       菜和菜菜       小城方       3 靴菜       竹萝方       小酒方       竹菜方       竹菜方       竹菜       竹菜         小板方       菜和菜菜       3 かあ       5 靴板       10 万方       11 万方       竹菜方       白菜       白菜       白菜         小板方       菜和菜菜       3 かあ       5 靴板       10 万方       11 万方       11 万方       白菜方       白菜       白菜         小板方       菜和菜菜       3 かあ       5 靴板       3 靴       10 万方       11 万方	wto	<u>র</u> ুরু ক্র	をき	3	が施	hter	わまづ	う選
小約     梨松菜     小約     ろ靴菜     小酒     小酒     小菜     小酒       小約     菜和菜     子小約     ろ靴約     方部約     5380     方部約     方部約     方部約     5380     方部約     方部約     方部約     5380     方部約     方部約     方部約     5880     行部約     方部約     5880     行部約     5880     行約     5880     5880	んわ	A B B	机路	ろ塗わ	が狐゛	රයා	わえん	を
小海     熟練菜     子かあ     ろ靴か     方靴か     子かか     子かか     子かか     子かか     子かか     み離末       小海か     桑畑菜     ろうかか     ろうかか     ろうかか     ろうかか     ろうかか     カシ菜     みかえ     桑雑       小海方     みが菜     ろうかか     ろうかか     ろうかか     ろうかか     カシ菜     小方か     小菜     か家か     桑維       小海方     みが菜     ろうかか     ろうかか     ろうかか     カジ菜     小ろかろ     か家か     桑維       小海方     みが菜     ろうかか     ろうかち     カジ菜     小ろかろ     か家か     ろか       小海方     みが菜     ろうかち     ろうかち     カシ菜     小ろかろ     かなか     ろか       小海方     みが菜     ろうかち     うかち     カシ菜     小ろかち     カタ     かな       小海方     みが菜     ろかちう     ろうかち     カシャち     カシジ     カタ     カ       小海方     みが菜     ろかちう     うかち     カシャち     カシャち     カシャち     カ       小海方     みが菜     オかち     ろうかち     カシャち     カシャち     カシャち     カシャち     カ       小海方     みが菜     オかち     ろうかち     カシャち     カシャち     カシャち     カ     カ       小海方     みが菜     オかち     ろうかち     カシャち     カシャち     カ     カ       小海方	んたえ	A DEA	わわわ	ろう	かろ	kháb	わえん	ん北
小酸力     蒸馏泵     分散小     ろ削小     ろ削小     分削小     分配和     均蒸和     蒸減       小酸石     蒸和1泵     ろ削か     ろ削か     ろ削か     方削か     ん     均蒸加     蒸減       小酸方     み加泵     ろ削か     ろ削か     ろ削か     方削か     ん     均蒸加     蒸減       小酸方     み加泵     ろ削か     ろ削か     ろ削か     方削か     人     均蒸加     充減       小酸方     み加泵     ろ削か     ろ削か     方削か     人     小酸力     均数力     充       小酸方     み加泵     ろ削か     ろ削か     ろ削か     ろ削か     ろ削か     ろ削       小酸     み加泵     子加系     ろ割か     方削か     小酸     万減     万減       小酸丸     み加泵     子加系     ろ割か     方削     万減     万減     万減       小酸丸     み加泵     子加方     ろ割か     力減     万減     万減     万減       小酸丸     み加泵     子加か     ろ割か     力減か     力減方     万減     万減       小酸丸     み加泵     子加か     ろ減か     カ減か     力減方     万減     万減       小酸丸     み加泵     オ加か     ろ減か     カ減か     力減方     万減     万減       小酸丸     み回気気     オ加約     ろ減か     カ減か     力減方     万減     万減       小酸丸	んめ	ALTER.	んれわ	ろ戦烈	かう	ත්ත්	わまた	わる
小銀菜       桑桃菜       ろ 読み       ろ 読み       方 読 か       ん い       か 読み       か 読み       桑         小飯菜       み 読え       ろ 読み       ろ 読み       か 読え       ん ひ 読み       か 読み       方 読み       か 読み       方 読み       か 読み       方 読み       方 読み       方 読み       方 読み       方 読み       方 読み       か 読み       方 読み       う 読み       方 読み       方 読み       う 読み <t< td=""><td>hits</td><td><u>zhz</u></td><td>Shab "</td><td>ろ <b>ぎ</b>ん</td><td>わうか</td><td>わわ</td><td>わまた</td><td><b>7</b>21</td></t<>	hits	<u>zhz</u>	Shab "	ろ <b>ぎ</b> ん	わうか	わわ	わまた	<b>7</b> 21
小飯ご       みば気       ろうねの       ろうねの       方が点       小石砂       かかっ       小豆       かかっ       かかっ <t< td=""><td>んぼう</td><td><u>র</u>ন্দ্র</td><td>动机</td><td>ろ靴゛</td><td>ゐゔ゛</td><td>Ber</td><td>わた</td><td><u>A</u>ž</td></t<>	んぼう	<u>র</u> ন্দ্র	动机	ろ靴゛	ゐゔ゛	Ber	わた	<u>A</u> ž
小菜     みざかえ     けび     ろぎを     けび     んを     けまか     ちが       小菜     みがな     ろれな     ろぎ、     ちずち     方また     うまた	has	<u>র্</u> ষার	ろ 🌇	ろ <b>逐</b> わ	がわ	ん゛	わえる	<b>A</b>
小原わ       み始交       子小交       ろうど       わか       ブラはつ       内原わ       内原       内原         小原丸       み始交       子かご       ろうどろ       わかね       ブきがえ       カ原ろ       方ざ         小原ご       み原ひえ       オれ       ろうから       ろうから       カうかん       小を       ブざ         小原ご       み原ひえ       オれ       ろうから       カうかん       小を       ブ       ブざ         小酒か       み原ひえ       子がか       ろうから       カうかん       小の       ブざ       ブざ         小酒か       み原ひえ       オれ       ろうから       カうから       カからう       うざ       うざ         小酒か       みたのたえ       オカから       ろうから       カうから       カのらう       かた       うざ         小酒か       みたろ       オカから       ろうから       カうから       かた       た       ろうから       かた       かた         小酒か       みかかえ       オカかう       ろうから       カうから       かた       かた       ブ         小酒か       みのかえ       オカかう       ろうから       カうから       カのから       かた       うざ         小酒か       みのかえ       オカかう       ろうから       カうから       かた       うざ       うざ         小加       みのかえ       カから       うから	んるう	ゐ之を	ろうね	ろ 🌇	がえ	hBhB	わぼう	を
小原へ     みぎな     ろいろう     ろうそろ     わきれる     ブきがな     かたろ     かたろ       小だう     み家ひみ     ガれ     ろうかろ     カうかん     カをかか     かたろ     うざ       小だつ     み家ひみ     ガれ     ろうかん     カうかん     かたの     ウえ     うざ       小花か     みなかみ     ろうかん     ろうかん     カうかん     カかん     うざ       小花か     みなかえ     オかん     ろうかん     カうかん     かたの     うざ       小花ん     みおかえ     オかなか     ろうかん     カうかん     かたの     うざ       小花ん     みるかえ     オかなか     ろうかん     カうかん     かたの     うざ       小花ん     みるかえ     オかなか     ろうかん     カうかん     かたの     うざ       小花ん     みるかえ     オかなが     ろうかん     カうかん     かたの     うざ       小れん     みるかえ     オかなが     ろうかん     カうかん     かたの     うざ	んゑ	<b>চল্লা</b> হ	<i>ħ</i> ₿≙``	ろ遊を	かう	を	わぼわ	をと
小酒       ふ酒       小酒       小面       小面       小面       <	んぼう	る対象	子的	ろ 邎 ゛	わ 潮8	うれづ	わゑわ	わる
小酒     みば蒸     ろき     り     うき     うり     みば     みば       小酒     みばを     ろき     り     ろき     り     ろ     か     ろ       小酒     みばか     ろき     ろき     り     ろき     う     か     ろ       小酒     みばか     ろき     う     ろき     り     ろ     か     か       小酒     みざ     ろ     な     ろき     か     ろ     か     か       小酒     み     み     ろき     カ     カ     か     か     か       小酒     み     み     か     ろ     か     か     か     か       小酒     み     み     カ     ろ     か     か     か     か	んぽん	るを見	ろりろう	3 📷	ಶಿಷಿದಿ	龙领	われ	われ
小葱     みませを発     カかどを     ろきか、わきの     んうきか     わきの     たき       小葱小     みまかえ     オカなか     ろきろ     わきか     んきい、     わまの     んま       小葱     みまかえ     オカなか     ろきろ     わきか     んきい、     わまの     んま       小葱     みきろ     オカなか     ろきみ     わきか     んうきか     わきか     た       小葱     みきか     ろきか     わきか     んうきか     わきか     うきか       小葱か     みきか     ろきか     わきか     かきか     うき	んぼう	る意味	12n	ろ 讷	わぬん	を習り	わゑ	う遂
小酒         みかえ         オかなり         ろ 靴ろ         り添い         小酒         小酒         小酒           小酒         みろろう         オカキジ         ろ 靴ろ         わ 添い         小酒	んをわ	<b>7</b>	ろれわ	ろきを	わ 邎	314B	ゎゐ゛	<u>A</u>
්රා කෙරීක ආතා ට මත වන බොහෝ ආණා ක රාක්ත කක්ක ආගත තමා බොහෝ කොට	んを見	চাৰ্ক্ত	わかき	ろ <b>ゐ</b> ゛	わ 🕉 つ	んうぼわ	わわう	を
んぬわ みるをたい おうあう おうあろ わめを うき	んあん	みれた	物物	ろ 酒	わ 逐か	heren "	わわう	ん北
	hitu	ゐあゑ	わめ	ろう	わ む	んうねわ	わるを	を診
hah $banks$ $5$ $bar$ $bar$ $bar$ $bar$ $bar$ $bar$ $bar$ $bar$ $bar$	んねわ	る酒原	物圈、	ろうか	ಶಿ ಹಿಂದರಿ	杨云	わた	う逐
	hah	るれた	ろ 塗わ	ろぬ	わぬか	うねん	わる	を

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んねう	われた	30/100		うわうわ	わゆう	<b>み</b> れ
high	わらかえ	う <u>い</u> 、 、	ろ遊気も物か	うな	わぼわ	お
んの変	わんえ	3hth		う途を	わ <b>む</b> ろ	われ
んどう	われた	3hãh	ろうのわか	ううぼわ	120 1	われ わ
んぬわ	わるる	ろを	ろうのわった	うれの	わむ	<i>わ</i> 4
ん塗蒸	わるかえ	をあ	ろ塗かわる゛	hab	わめ	われ
ん塗う	わ愛れ反	ろりねる	ろ遂 わ溺わ	うか風	われん	る選
Jaho	わめえ	物的	ろ塗われ塗ん	h 🛮 h	われを	ん連
うわ	わたた	おわる	ろ遊をわどろ	うかを	われる	を
うれん	われた	扬荡	ろ遊りを	うれた	われわ	を選
うる	われた	招助	ろうわわを、	んえきを	われわ	を
うぼわ	わるかえ	35mb	ろ遊ゑわ遊り	んどう	おおろ	<u>A</u>
うぼん	わるため	ろを	ろうかわれ	た変わ	わ <sup>a</sup> o <sup>×</sup>	<b>A</b>
うわ	内和民	わる、	ろ節を務	んねうう	わわう	を塗
うわ	ゆうえ	わぬわ	ろ塗われ塗剤	hadab	われ	6
うわ	ため	わめ	ろ遊をわぶう	んわれる	わを	を
うわ	わう家	Ш.	ろ酇゛ゎ塗わ	John "	わねる	われ
うわ	われ気	ろれるわ	ろ 塗わ わ 塗 <b>ん</b>	ろれる	わわ	われ
うれん	われた	ろを	3 ≥a thtB	hhitu `	わわわ	₹.
うる	わを気	わわわ	ろ 塗ん われる	の演	ねる	を
うぼわ	わを見え	われ	机机	れ	わる <sup>、</sup>	を
うるん	われた	相類	thing theorem	んを診わ	わろう	を調
う瀬	わ愛れ反	われる	物额 物酚	んうきわ	わるを	を
うぼわ	わる意思	わめ	that the	んれつう	も変	を愛
うぼん	わわえ	30mb	机图 机旋	うちえる	わるわ	る北
うき	われる	<u>گ</u> ه	then the	55100	わざわ	われ
う酒り	われえ	ろぬ	抽题物物	んをうう	お客ろ	を
うるん	われる	ろわ	抽路 机药	うれる	わる	<u>A</u>
うん	地名	ろ 瀬ね	物图、物码	· 子魚	われび	を
うれわ	わるる	ろうかり	that the	んうきつ	われん	<b>A</b>
うる	われゑ	ろぼう	thus the "	గ తీసే	われた	<b>A</b>
うろう	われる	ろんのわっ	the that	んうれつ	われる	ā.
うじ	力和原	ろうろ	抽动 机乱	ん柔わ	われわ	<b>A</b>
うわ	<u>ろ</u> 塗蒸	ろろう	thes the	ろめ	われわ	<u>A</u>
うわ	<u>ろ<u>い</u> ろ<u>い</u> ろ</u>	<b>否</b> れ、	わわわ わあろ	うなん	わ	<u>A</u>
うう	Sin	初め	抽飯 机筋	んを柔	<b>3</b> ☆``	64 1
うきわ	3312	<b>孫</b> 昭	that this	んわわう	ろ泣う	<u>A</u>
ゔゎ	ろんゑ	ねむ	the the	をごわ	ろ絵を	んえ
うわ	Share	ろりあり	抽路 机药	khest	ろ◎ゑ	<u>A</u>
うごう	Share	th	that the	khej	ろぬわ	<u>à</u>
*	ろを支	うえる	机泵 机滚	んた	ろきわ	われ
∛an⊳	3000	をあう	物链 机筋	うわわ	ろぬろ	わえ
¥r.	ন্দ্র	<b>3</b> 55	わわう わかわ	うぼわ	<b>Š</b> ≙`	われ
Ůn to	- এই প্লি	子的	抽象机滚	うか	35	<u>A</u>
ЙЮ́	ろろれた	ろ願	おわわ わかう	んんぼわ	ろうづ	を
×	3 <b>2</b> 12	<b>ろ</b> ゑ	机动 扬格	んえんえ	ろを	<u>z</u>
<b>逐わ</b>	<u> এ</u> জন্ম	ろを	机额 扬畅	んむを	ろうえ	る
逐わ	32 E	Salah	抽動 扬机	<b>予約</b>	ろうわ	<b>1</b>
) Maria	ろわえ	ろのを	h震、 扫机、	<b>INT</b>	ろうわ	₹.
) Maria	3000	ろ <b>塗</b> わ	物名 招歌	んうざわ	3 b	を

逐	3	55	れるか 招変	hith	333	を
<u>ふ</u>		30100 Shari	おあ おろ	/102570 /1210	35 35	<u>z</u>
 ***	3012	<u>こ</u> 3 涵わ	机链 招助	んわえづ	 Balu <sup>°</sup>	を
<u>ل</u>	Sala	<u>」</u> わる	thish total	ん蒸ぎも	34J	
∛an b	3035	るを、	相差 招级	Josef 1	马枪	2007 1007
<u></u> 塗わ	San	<u> ろか</u> ろ	机石 招助	ට්ත්ති	马枪	<b>ස</b> ම
<u></u> 塗わ	San	ろ 透気	おんわ おむ	の遊を	3400	を
ù R	300	ろきあ	わる おわわ	んを変わ	3400	えき
≧n v	Ship	30/4b	机症扬动	That	 ろ約	254
1 an	SHIE	ろきう	that the	んわめを	ろれわ	<u>A</u>
Э́о́о́	SHE	ろううか	机作物	わう	343	Â
ث ف ت	Ship	ろわ	わら おあ	动处	3h	<b>A</b>
NO.	SHE	ろりを	おうち おろのわ	33h	3æ <sup>°</sup>	754
ЙО	3000	をわ	わわ おみ	hani	350	3
∛ach	3000	动貂	物產 招遞	Then	350	<b>A</b>
∛ach	3000	をあ	机透 招助	うった	ろあん	<u>A</u>
塗わ	3000	AD	ねあう 招ゐ、	うわわ	3.20	われ
釣り	Sha	ふる	物質、招麗	hão	3	<b>A</b>
¥€.	3000	55100	材心ろ おろうわ	hBhB	3	を
¥€.	3000	短わ	材心も おろの	を顚	ろあわ	3
∛an⁄or	Same	ろを	物が認知	んを図り	350	<b>A</b>
∛an⁄or	ろの支	杨蜀	机滚 招發	んわきを	ろきり	を
<b>Ĭ</b> O	ろゐゑ	ろわわ	物验を 招致	hhato`	ろきり	る本
<b>Ĭ</b> O	3 <b>2</b> 12	动旗	オ№う 招震゛	hão	ろきわ	<u>A</u>
й <b>љ</b>	3 <b>2</b> 50	お影	物》、杨登	んむうわ	ろきわ	を
й <b>љ</b>	<u> এ</u> জুব	ろうぼう	招扬怒	theory	333	ත්
∛aab	SAR	∛ach	招格 招袖	れき	383	わる
<b> 踏</b> わ	S RA	ろわれる	おわ おあ	36ab	ろを	みき
うな	5 <b>8</b> 88	AD `	杨杨 杨薇	Ξhu Ň	ろを	われ
Ì€ ۲	SAR	んむ	杨娘杨奁	553M	ろを	わき
<b>NAS</b>	ろ愛え	ろりを気	杨榕杨	33/13	ろゑ <sup>*</sup>	<b>7</b> 31
300	38 B	をむ	招机 招惹	れらう	<b>3</b> ゑ <sup>*</sup>	われ
う	322	わぬわ	杨鹤花杨奁、	わぬ	<b>3</b> ゑ <sup>*</sup>	34
う	ろを見	んわう	招机、招乱	ろちの	<b>3</b> ゑ <sup>*</sup>	わ巻
۱	ろを気	<b>33</b> 10	扬扬 扬扬	透影	ろぼう	われ
塗わ	322	ろわめ	招强 扬油	うわわ	ろぼう	ひき
愛わ	388	ろうわ	ねるわ ねみわ	んを図わ	රඹුට	を
塗わ	3260	物路	おろわ おろわり	んろうう	රඹුට	るの
塗わ	ろあんゑ	うご	扬励 扬励	るなる	රඹුට	わぼ
<b>A</b>	ろを決	ろきを	杨薇杨颜	んな	ろぼう	<u>A</u>
愛わ	- স্ক্র	ろうえ	招照招腔	ろめ	ろぼう	<b>75</b> 1
愛わ	Ship	ろわ	杨楚 扬乱	うちきん	ろぼう	るふ
愛 ゔ	Share	Solution	招告 招加	うかわ	ろぼう	145
ت ک	Shite	马露	招助招助	ん変更を	ろぼう	<u>A</u>
遊	马纳索	ろ資気	超药扬机	施扬	ろぼう	を
遊	Shite	3 🕅 bb	肠炎招致	hat	ろぼう	を
) 塗わ	Share	颈汤	招致、招勁	んんぼわ	320	<u>A</u>
<b>塗</b> む	ろんを気	加る	1330 13533	ん塗び	3 <b>2</b> 0	を塗
<b>塗わ</b>	Saha	ゐ	1330 13533	うんえう	3200 	34
塗わ	ろ加速	加奶	超极 扬动	产品	ろゑ゛	を

適わ	ろんゑ	ろ源	杨杨	移動	んごを	ろゑ <sup>×</sup>	<b>A</b>
<b>遂</b> わ	333	ろんろう	h <del>5</del> hh	ねわ	んむっか	Sæ <sup>°</sup>	<b>A</b>
<b>遂</b> わ	<u> ত</u> ্ত্বার	ろんを	わ <b>ろわ</b> わ	招助	をあ	Sæ <sup>°</sup>	<u>A</u>
<b>遂</b> わ	<u> ত</u> ্ত্বাক	ろ、家	おおわ	ねっか	h 🖾 b	Sæ <sup>°</sup>	<u>A</u> A
<b>遂</b> わ	3	うた	おおわ	扬克	うれる	35	わふ
<b>透</b> わ	3300 A	われ	おおわ	扬克	んをれる	35	ジ
<b>遂</b> わ	<b>3</b> 55	hbh.	おね	扬蓬	うかの	35	れき
<b>遂</b> わ	ろうえ	hn.	おね	扬速	を塗ね	383	Ì
<b>遂</b> わ	<u>ক</u> ্থিন্দ্র	ろいうか	おね	扬乱	<b>Ina</b> b	383	<b>A</b> A
<b>遂</b> わ	ろ離え	332m	杨颓	扬乱	うため	383	ත්ෂී
) 塗わ	ろ診療系	53	杨颓	ねう	h 🖥 h	ろわ	を
) 塗わ	Saha	ろうえ	杨颓	ねう	ん戦る	ろわ	ත්
遊	<u>ૐ</u> `ゑ	ろを	杨乾	ねず	ん 塗わ	ろわり	ත්ෂ
遊	hares.	わき	杨乾	ねず	化和西	ろわり	64
愛 ジ	われ気	ろきわ	杨乾	扬う゛	<b>This</b>	ろあわ	7 <b>2</b> %
愛わ	われた	3has	扬动	杨》	うかう	ろあわ	わえ
) Maria	われた	Z€n`	松松	杨	わわ	ろあ	<u>A</u>
) Maria	わるの	33 Th	扬动	超ぶろ	をお	3	わふ
塗り	わるる	33 Th	扬动	超ぶろ	をお	3	わふ

			材	th. Ht	*		
І ІҲЦ҈ от	±1+±105,000 151.⊺∨	ѡѱѱ҃ӸҲ	<sub>ατ</sub> Τί <del>α</del>	↑பு≹ூப	- Іфіцьт	<sup>1</sup> т%-хафоЦрт	9↑Џіӿ҄Ҟ҉ӏҴҬ҈іѦ҈҄Цҋ
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塗わ	われる	ろをわわ	わ₽₽b	わえ	khesi	ろきを	<b>A</b>
١	われん	相配	bbt∕bb	わを	hBao`	3.85	を
3 and the second	わる	the states	われわ	わを	ん 猶ろ	ろあん	を
) Je	わざわ	3 🕅	われわ	わを	ん資源	ろきづ	を
3 <b>2</b> 0	わるを	) I I I I I I I I I I I I I I I I I I I	わわわ	わるか	れの	ろきづ	わる
<b>iii</b> ah	わわ	<u>ठ</u> केंद्र	われる	わね	handh	ろちう	を
う	わわ	55755	わね	わあ	んねまう	ろを <sup>、</sup>	を
₫ <b>c</b> h	われ	ろもで	加藏	わるか	うかわ	ろを <sup>、</sup>	<u>A</u>
<b>塗わ</b>	われる	5 ¥₿	加藏	わだ	hh	Sh	を
∛c⊅	われ気	ろうある	加魏	わおう	うかわ	343	みた
もう	われ	颈旋	われを	わおう	hbad	343	<u>A</u>
ù đại	われつ	557M°	わた	わだ	htellu	ろわわ	を
塗わ	わるか	thti	わわ <b>わ</b> ん	わを゛	化验室	ろわわ	を
Ů <b>∂</b> o	わえり	机疮	われづ	わを゛	施短	ろわわ	を整
B	わまた	ろ <b>淡</b> 気	われづ	わを゛	んをき	ろわわ	を
通わ	わち	than 1	われ`	わを゛	んわわ	ろね	を
ß	わたえ	<u>ठ</u> छेट्र	わわれ`	わを゛	h 🖢	ろね	を
₩h	わん	んうう	わる	わを゛	57365	Sha	わき
どわ	われた	おいろ	ね怒	わを゛	·汤わ "	ろれを	を
*	わら	机石	ね怒	わを゛	化物	ろれを	を
うふん	わえ	ろんねり	わろわ	わを゛	うちをわ	ろれを	<u>A</u>
うわ	b≌゛	おめ	わざわ	わhh	を習り	Shh	を
うど	ね◎ゑ	加额	わざわ	わhh	hte "	ろんづ	を
ううか	われ B	おれるう	わる	わhh	hben	ろんづ	を
ううわ	われを	ろうかり	物類	わを゛	んねまご	3hu <sup>°</sup>	を
うず	わるの	these	か変	わを゛	৸ঠাক	3hu <sup>°</sup>	を
うれん	わきん	ろを	ねを	わを゛	わあん	Ξhu Ň	を
うわ	わわわ	ろきを	ねる	わを゛	をごわ	පත	を
うも	わめ	おわ	ねる	わを゛	knaz	<b>ろ</b> 多	ん建
うるん	われる	ろ塗わ	ねめ	わを゛	んむわ	<b>ろ</b> 多	を
うきり	わわう ゛	ろうろう	わる <sup>、</sup>	わを゛	んれまう	<b>ろ</b> 多	を認
うぼう	わたえ	ろわ	わわわ	わおう	hBhB	ろうわ	を選
ご願い	わたろ	thto	わむ	わおう	んごわ	Sob	を
う通わ	わえん	ろきね	われ ろ	わおう	うかわ	ろわ	を
うぼう	わぬわ	that B	わわわ	わおう	んを始め	ろわ	を整
300	わを *	加める	わわわ	わるか	る金を	ろうわ	ん <b>建</b>
うぼわ	わぬ	招頭	わわわ	わるか	んむれる	ろうわ	64 A
うめ	わらわ	ねぎ	わねる	わを	<i>kbi</i> bb	ろうわ	ん通
うた	わらう	ろう	わね	わを	んうざわ	ろうえ	を
うわ	わぬゐ	わる	かえ	わ癒	をきわ	ろうえ	い
うず	<b>DAR</b> B	杨杨	かを	わ癒	んなび	ろを	を
うえ	Jan bar	子小的	お乾	わね	うるわ	ろを	ā.
うわ	තන	わる <sup>×</sup>	わわか	わね	ねろろう	ろを	ん
うろう	තා	わむ	われん	わぬり	んわれる	ろを	huil a
<u>う</u>	ねん	われる	わわう	わぬわ	んろきわ	Sh	ん選
うきゃ	みわ	わまう	わわ℃ `	わぬり	hand	ろうか	を

うち	ත්ත	扬速		わち	るる	ろうづ	んな
うた	tatto	わめ		わを	hb	ろうづ	ん
うわ	みえわ	ත්ත්	わわわ れ	<b>Ъ</b> ₹`	heetu "	පත්	ると
んごう	みを	ろんわ		ත්වේ	うわめ	පත්	<b>A</b>
ん診療	みあん	ろりた気	初移 れ	われ	んをおう	ろうづ	ත්ෂී
んぬわ	おねる	わちあ	わねる れ	b乾	を巡か	3DÍ	ん達
んうう	ゐる	わ願	わわわ れ	カ蒸	を加え	35)	ん
ht	ක්ති	わねる	わわわ れ	かあっ	んわれる	35) <sup>°</sup>	ん差
んぼう	ゐ゚ゑ	わを	わわわ れ	わえり	んわれる	ろう゛	んな
んう	And	ゑわ	わわわ れ	われ	BB	ろう゛	<u>A</u>
かね か	<u>A</u> S	わえん	わわわ れ	ЪØS	を習り	<b>S</b> àr	んな
んたえ	ASh	おわ	わわわ オ	わゑ	んゑれる	<b>S</b> à	んな
んれわ	える	ゑを	わわわ れ	ත්ත්	んわぼう	<b>S</b> à	<u>A</u>
んをう	AB	招勤	わわわ れ	nan	んわれら	<b>S</b> à	64
んあん	ゑむ	3 <sup>°</sup>	わわわ れ	わた	風初	<b>S</b> à	を
んあり	<u>A</u>	物路	わねる れ	わま	を塗び	ろぬろ	ん塗
んをわ	ゑゑわ	ろ蔥゛	わねる れ	わねり	んを変わ	ろ言ろ	を
んそう	ゑを	おろう	わかる れ	ЪЪ	handen	ろ言ろ	を
んぽん	ゑあん	the "	わね オ	わゆ	んむぼわ	ろ塗ろ	を始
んぼう	ゑぬゐ	物题		わめ	んろをわ	ろ塗ろ	を
んぼわ	A B	物習り		われ	かろん	ろ塗ろ	を
んるう	200	ねむを		加索	わねる	ろ塗ろ	3
hat	<u>a</u>	扬楚		ntab	んぼう	ろ塗ろ	を
hate	をわり	わぶろ	わねる れ	74B	hhite	ろ塗ろ	んぼ
hat b	<b>を</b> れ <sup>*</sup>	物源		toto	を認わ	ろぬろ	3
hata	を変を	<b>換</b> 格		わわう	hnzh	ろ塗ろ	3
んむ	をわ	物》	わわわ れ	かを	ん気着し	ろ塗ろ	ん差
んたえ	をわ	5300	わわわ れ	わね	പ്പാത	ろ塗わ	を
んわ	をわ	わ		わわ	khno	ろ塗わ	ん差
witch	をわ	わかの "	わわわ オ	hh h	を゛	ろ塗わ	う
んわ	を柔	わねる	hoto t	තති	kb	ろ塗わ	ha
んわう	を愛い	ねっか		わを	を	S≌ð	う
hàn	をあ	招給わ		<b>か</b> るわ	を歓び	ろ塗わ	hid
んわ	をも	555		わるわ	khab	S≌Ď	を選
habb	をん	杨怒	わわわ <b>オ</b>	わる	あう	ろ塗わ	うき
<i>h</i> ao	をわ	ねあう	hoto h	かむ	ををき	ろ塗わ	3
んぞう	<b>を</b> う゛	ろ <b>ゐ</b> ゛	hoto t	わた	khtrö	ろ☆わ	を獲
hen	を塗を	わぼり	hoto h	<b>2010</b> 0	を塗ん	ろ塗わ	ん北
h BE	んれち	ろぬろ	加奶 1	ъrв	hte	ろ☆わ	を選
んぼう	んれづ	わえん		£ி	んろきわ	ろ塗わ	hid
h⊠n	んろう	ねぼ	加奶 1	B≧ĥ	んわれる	ろ☆わ	6
hæ	here "	杨苍		∌்≵	を濁わ	ろ塗わ	う
んたび	শিক্ষ	をおび		£ி	を知る	ろ塗わ	う
han h	んねろ	初的		bB≙`	を塗う	ろきわ	h
んな風	んなを	物震		ති	んわれづ	ろ塗わ	hite
640	hat the second s	わる		B R	んれきを	ろ塗わ	34
han b	hold the second	ねむし		あわ	ED n	ろ塗わ	<b>ジ</b> 密
h	んえか	わわわ		おう	んればわ	ろ塗わ	6
をう	んぼん	わを		3ki	んれるを	ろきわ	h
をん	んをつ	物類		西极	んかざわ	ろきわ	hite

を読	んあん	ねる	わわか	おわ	කි	ろ給わ	じょ
をわ	んぬわ	根を	わわか	拓乱	を適わ	ろかわ	38
をむわ	ん た ん	物教	かを	ねむ	んわわり	ろ塗わ	h
を診	hat	わる	かを	招額	hBhB	ろ☆ゐ	60
をうう	んを	ねるう	わわれる.	おわ	をうわ	ろ☆ゐ	ジ
をか	ん塗ろ	杨族	わね	招を	を	ろゐ	ジェ
を気	ん塗蒸	校察	わね	扬飘	を濁わ	ろゐゐ	うき
をわ	<i>h</i> ≙```	わえう	わわわ	招願	khab	ろゐゐ	hila
をうわ	うわ	ねるわ	わわわ	招願り	をきぬわ	ろゐゐ	うき
をう	うれん	ねあう	われる	扬ゐ゛	をある	ろ☆ゑ	うき
をん	う <u>あ</u>	反応	われる	扬旋	をむわ	ろ☆ゑ	3
を検索	う 夜	机路	わわわ	扬励	んみわわ	ろ◎ゑ	を診
をわ	<b>う</b> る <sup>*</sup>	短期	わる゛	杨弼	をおわ	ろ☆ゑ	う
をわ	うわ	物を	わめ	ねめ	を塗う	ろ☆を	ん酒
をん	うを	える	わろん	杨薇	をあわ	ろ☆を	じょ
をもう	うわ	わを	わる	わらわわ	もず	ろ☆を	ん愛
をあ	うわ	杨柔、	わる	扬む	を認め	ろきん	うき
を教え	うた	招额	わざわ	扬轨	を塗わ	ろきん	6
をわ	うる	杨苍	わろわ	わろわわ	を予わ	ろきん	ジェ
をあわ	うぼわ	ねっか	ねる	杨昭	を感わ	ろきう	し、
をを	うるを	物卷	わかれ `	ねあう	をうわ	ろきう	んぼ
を動	う <b>ゐ</b> ゛	ねむ	われん	扬骤	あう	ろ泣う	58
を願	うぼわ	<b>授</b> 鼐 <sup>"</sup>	われた	招習わ	を思わ	Så″`	- Ja
を愛わ	う変を	わを	われる	tBn "	をず	S☆ <sup>°</sup>	h
を柔わ	うゑ゛	初知	わわわわ	おを	khhb	わ	hit
を柔	うきり	わむ	わわ	おわ	んれ震	わ	ん選
をおう	<b>う</b> 液系	わわわわ	超う	招	んわうづ	わ <sup>r</sup> B	ん
をか	うあん	ねおわ	超き	われた	hzab	わる	hit
をため	うね	扬机	ಗರಿಖಿಂದಿ	われわ	ほぼ	われわ	を
をわ	うわ	Z€nb `	ಶಿಖಿಶಿ	tha"	施威	われわ	<u>A</u>
をわ	ごを	をあう	わう <sup>゛</sup>	this	んずのう	わわ	<u>A</u>
をわ	- jh	ろんねる	ねっか	机动	んうきを	わわ	<u>A</u>
をめ	ううわ	乙酮	杨蒙	机路	んわゑ	われる	
をか	ごえ	物を、	ねうわ	われん	を濁ゐ	われる	hit
をわ	රාන්	たん	ත්ර	机肠	khhij	われた	じょ
を気	うふろ	初め	わろろん	11/13	んろぼう	わた	ん愛
をわ	うゐ	わわざわ	おね	わむ	んごを	われを	んと
をわ	うきん	わちう	杨杨	物额	hord	われ	ん選
をわ	*	わ335	ねもう	机貂	るあ	わち	ん
をわ	塗わ	动动	扬额	わまう	んわぶを	われび	<b>ん</b> と
を	¥160	物感	おわ	加顯	杨阳	ゎれ゛	ん
をう	ي ب ک	ねめ	杨鼐、	われこと	を勤	わる	んぼ
をか	逐り	根を	扬乾	われう	KNAZ	わる	う
をえ	迷を	わゑ゛	お願わ	机酸	んわらわ	わる	6
を反	<u>3</u> 0	わどわ	招麗	that	んを読む	わるわ	る後
をわ	<b>き</b> わ	物を	招陸	this	を勤わ	わるわ	64
をわ	Ìn the second s	ろもの	おおわ	机短	る家	わるわ	<u>A</u>
をわ	No.	おかか <sup>×</sup>	杨阳	thto	んれっちう	わるわ	んぼ
をわ	* <b>7</b> 0	反抗	杨乾	the "	をあ	わる気	う迷
をわ	<b>塗か</b>	かどわ	おわ	机短	をかわ	わるを	う資

をわ	<b>X</b>	おゆわ	超的" that	ක්කා	わるん	he
をわ	No.	13 240) ろ 逐う	おを わる	_	1 <u>2</u> 0 わろう	7043 A
をわ	No N	3 - 30 35:36	超的 机管		ねる、	~~ 23
をわ	) Jero	ため	超图 打图		わる `	
をわ		わぬわ	too the	_	1250 わぬ	64
をわ	遊	おを	超强 われ		12世	ん <u>後</u>
をわ	· 遊 わ	物を	notic that		わわわ	ん 通
<u>を</u> わ	20	初ん	动物机	ANTO	われ	ん遂
をわ	¥u⊅	石山石	お わ 塗れ		われる	<u>A</u>
をわ	举在	ねむん	わぶん わぶみ		ねゑ	38
をわ	5	根を	<b>オれ</b> 塗わ ゎ 塗ろ	をかき	わた	38
をわ	どう	物震、	わら゛ ゎ 塗む	を読	わわ	ん遊
をわ	۵. ا	撬链	相差 わ 読	、 んれ い も	わめ	hà
をわ	<b>塗</b> ろ	をわ	おわらわ わどわ	る急を	わ <sup>a</sup> o <sup>×</sup>	52
をわ	<u>ک</u>	かるり	わめう わる	ある	わ <sup>a</sup> o <sup>×</sup>	34
をわ	塗ゔ	拖圈、	机级 力凝	6000	ねる	3
をわ	Shinb	机机	栁石 わる	<ul><li>んゑ葱わ</li></ul>	ねる	を
をわ	Share	わ	われる わ 靴石	h h	わわ	h
をわ	zhañ	ねるう	物語 わぎ	5 <b>5</b> 0000	わわ	hê
をわ	3h83	わわ	村を わ 遊	<i>kni</i> e	わね	64
をわ	ろれるみ	ろきわ	初これ わぶれ	http://	ねゑ	反義
をわ	zhen	ろ 逐	村園の わ遊	を勤	われた	を
をえ	3hos "	ねめ	物気の気	んかを	われん	を
をえ	<b>Zhao</b>	3 密	机旋 力 藻	、を゛	わめ	を
をわ	Shuth	わる	わぬわ わぼれ	ある	<i>わ</i> ₽0 <sup>°</sup>	ん生
をわ	zhize	たわ	than the bige	をう	わぬ	うき
をが	引を	协会	柏勒 为勤	<i>`</i>	わわ ろ	60
をが	<b>Sh</b> ibi	をあ	おわわわ わ 淡を	ික්	わねわ	わえ
をわ	<b>Sha</b> iji	わぬり	the trans	んどん	われわ	ん
をわ	<b>Zh</b> ao <sup>°</sup>	物名	that has	んむ変わ	われわ	ん生
をわ	<b>Zh</b> ao <sup>°</sup>	杨格	われぬ わぬ	khib "	わる	んき
をわ	<b>Zh</b> ao <sup>°</sup>	検索を	this his		base.	る
をわ	znaci	わかわ	わめう わめ		わた	る
কাক	zhan	<b>极</b> 滚	物類わり		わめん	うき
をわ	ろれを	杨阳	物であり、おうな		わめづ	んき
をわ	zhada	ねる	物れ、お教		わるう	6
を	zhaz	物意	物物わり		わぬ ゛	hit
をわ	3has "	thto	物物われ		わゑ	を
をむわ	3næ	たる	that b in		わえる	う
をむわ	3h Sho	杨佑	ろ塗゛わ塗を		ね死	ジェ
をむわ	zhadi	たう	ろ 塗を わ 塗み		わゑわ	う透
を設め	3htrb		ろ きあ わ きれ		わぼわ	ねん
をあい	塗う	根類			わえつ	<i>М</i> ё́а 7-4
をあう	塗わ	302000	ろう わ あ て ご		わえつ	
を愛	۵. ۲	ねる	ろうがわか		わ た	68.
を愛わ	5 **	おかわ	ろ資源われ	hhab "	わ変え	ん選 ごれ
を致わ	¥Ф ***	わかぶわ いたか	ろ塗か わる		わまた	う
を願い	ي تعد تع	わかん ` た ごわ			わえん	h₫ ₩
を動	ي بر بر	わ <b>塗</b> ゐ	ろ猶、わろう		わ <b>え</b> ん	う <u>済</u>
を認う	کی	<b>200</b>	ろうん わぶん	- Fer	わえづ	な

をを	∛ab	おを	ろうを	わ 逐か	うわ	わまづ	を
をわ	う	Ì۵D `	ろ 🌇	わ 逐か	うんねっ	わゑ゛	わる
を着り	<b>塗わ</b>	MAS	ろ資わ	わどを	文化	お柔゛	われ
を認知	<b>塗</b> わ	方類	ろ 猶ろ	わどを	石城	お柔゛	38
をむ	う	われ B	ろ 泌	わ遊を	わあん	わを	を塗
をもう	うきわ	扬速	3 <b>ව</b>	わどを	hhas	わを	62
をわ	ううわ	th	ろ 遂ん	わ逐か	を鬱わ	わきろ	<u>ک</u> ند
をわ	う活ろ	<b>گھ</b>	ろ遂を	わ 逐か	んむきり	わきろ	ね
を加え	う漢	芬选	ろ瀬魚	わ 逐か	んうれつ	わきろ	<b>7</b> 32
をん	うねう	3hto"	ろ 遂わ	わどん	ゔ゚゚゚ゎ゛	わるろ	われ
をう	うた	<b>极</b> 极	ろ 遂わ	わるう	ん資	わるろ	64
をうわ	うわ	<u>S</u>	ろ遂わ	ゎ゙ゐ゛	ん <b>逐</b> ん	わをわ	る
をわ	<b>5</b> 86	555	ろ塗わ	ゎ゙ゐ゛	33/13	わをわ	<u>A</u>
を気	ん塗う	ろ、ころ	ろ遂わ	わ 🏜	えわ	わをわ	₹\$¥
をう	んきを	ねむね	ろ遂わ	わ <b>か</b> ろ	んうもの	わをわ	h
を診	んゆう	招助	ろどろ	わ <b>ề</b> ơb	んをわり	わをわ	を
をむ	んを	ろかれ	ろどろ	ゎ゚ゎ	ん変わ	わをわ	<u>A</u>
を読え	hat	ゎ゛	ろどろ	わぬ	knab	わをわ	う
をふん	hito	ろ <b>ぶ</b> ね	ろどろ	わう	わあん	わをわ	を
をむう	has have been a second	物源	ろどろ	わきを	ねるこう	わをわ	を
http:	んれん	ろかわ	ろ <b>塗</b> わ	ゎ゚ゕ゙	heter	わをわ	ත්
んわ	を塗ね	th	ろ遂わ	່ ອີ⊅ັ	ん変わる	わをわ	54
htt	を予	3h/u <sup>°</sup>	ろ遂わ	わ都ろ	んんわ	わきろ	<b>75</b>
んだ	をあう	ろきを	ろ遂わ	わ ぬわ	んろ゚゚ゎ	わきろ	<u>A</u>
hB	を蒸	ろを	ろ 遂わ	わぬ	hne	わきろ	を
んぼわ	をむわ	<b>Zh</b> Si	ろ遯ゑ	わ歓を	here	わきろ	み運
る際	を <sup>か</sup>	ろめ	ろ遂を	ゎ゚゚゚゚゚゚ゔ	子翻	わきろ	ね
んそう	を恐ん	<b>5</b> 66	ろ遂ん	わる	萀	わを	われ
hab	をわ	33 d	ろどう	わ 塗わ	うねえ	わを	わき
んわ	ゑ塗わ	ねめ	ろ遊゛	ಶಿ ಹಿಂದಿ	hha	わゑ゛	る後
have	RÍ	かわ	ろ 済ろ	わ遊を	を踏	わゑ゛	う運
んもう	えをう	机路	ろ漢わ	わ ಹಿರ್	んわきわ	わえづ	を
we was	え 変を	極を	ろ 🌇	わ瀬	hpto`	わえづ	う
んわ	<u>A</u>	机路	ろ遂を	わ塗わ	hති	わえん	を
んな	ゑれわ	わわわ	ろぼう	わ瀬魚	<i>k</i> れあり	われ	る後
んちう	ゑわ	んねつ	ろ狐゛	わぼう	んかの	わまた	われ
hits	â.	Zh∂hů <sup>°</sup>	ろ 適分	わどろ	わわ	わまた	<b>6</b> 5
んぼう	র	动机	3 塗わ	わ遊り	33Sh	わた	<u>A</u>
haz.	கூ≗`	ろ 讷	ろ 談を	わ 遊を	ん゛	わえる	を
んむ	ゐゔ	ろうね	3 🔊	わ遊゛	hBhB	わぼわ	を
んゑ	73hu	bBà`	<b>ろ</b> ً⊗`́	わ塗わ	lÆ	わぼわ	を
んぼり	みを	子的	ろ塗わ	わ遊ゑ	うれび	わえわ	わる
hãh	みえ	පොති	ろ邀ゑ	わうが	违派	われ	わぬ
んぼう	るな	扣	ろ塗う	わ 遊	を習り	わゑ	う
んをわ	at the	ろれわ	th.	わ 🖾	加招	わぬ <sup>、</sup>	ā.
んを見	みわ	わぶを	thttp	ಶ ಹಿನ	hith	わわう	を
んあん	ಗಿತ್ತಾ	わぬわ	物概	わ 塗ろ	heth"	ත්වේ	ん選
<i>kil</i> u	みれを	わめ	thrib	わ ಹಿಡಿ	hinth	わた	ん逐
んねつ	わぷん	わ遇 <sup>~</sup>	机图	ゎ塗ゔ	るな	わるを	い 、 、
hah	わら゛	ろ 塗わ	机石	thatB	和新	わる	を選

んれう	わえ	ろわれる	the the	うわわ	わめつ	みを
んち	われる	ゔ゛゛	机图、机构	うな	わぬわ	われ
んえ	わきを	Shink	that the	う途を	わる	われ
んうう	わゑ゛	ろれ着わ	thic the	うぼわ	わね	わる
んぬわ	われ	33巻わ	おれおう われゅ	うれの	わわ	わね
ん診療	わめる	をあ	thtas that	れなわ	わめ	われ
ん唸う	初初	ろりわわ	things thick	うえ	われん	みき
うわ	わわ	わぬ	that thes	ん <b>逐</b> ん	わた	ん通
うわ	わわ	机动	抽動 抽驗	うった	わね	を図
うれ	わろん	15 B	that the	予診を	わわ	を差
うる	わる	初か	the that	る絵を	わわ	を
うるり	わね	35 <b>2</b> 10	物面、物肠	んきう	わる	<u>Zh</u>
うろん	わ塗ん	ろを	theor these	な変わ	わむ <sup>×</sup>	<b>A</b>
うわ	わぬろ	加る゛	抽動 机颤	പപ്പാ	わわ	んな
うわ	わえ	われわ	the the "	んわぬわ	わわ	ん選
うわ	わわう	れうづ	物を わぬり	んなる	わた	を
うわ	われわ	<b>а</b> р	this this	John "	わねる	われ
うわ	わきを	子的石品	抽迹 机石	3400	わわ	われ
うれん	わを	马旋	抽题 机短	hhite "	わわ	<u>A</u> A
5%	わ願	わわ わ	thas that	の源	わる	を塗
うぼわ	わる	われ	おんろ わろろ	ħ	h∕S <sup>°</sup>	を
500	わぼわ	物额	the this	んを塗わ	ත්තිට	を
通	われ	かる	the the	んうきわ	わるを	を
うぼう	わわ	おぼわ	the the	hintos	わ変象	を
うぼん	わた	Shah	机动格		わろう	54
通	わる	<u>」</u> 塗わ	机走扬的	55476	わるわ	初
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をう	hat the	物旌	おかわ わかえわ	hhat	ろきわ	6 <u>0</u>
をふん	గుడిశ్ల	物额	おかわ わね <sup>、</sup>	んわざわ	ろわ	る

<b>≁</b> ⊚.*≿	1.24-2	. 7. 627		+255	マネギー	二分.
<u>を</u> ふ た	ん愛え	ねる		<b>を</b> のう	ろふわ	
をむ	ん変え	根を	おれる わめる	をかきり	ろふわ	が
を必わ	ん遊気	ねること		んわれわ ( 70% 7	ろ塗わ	ジェ
を <u>い</u> たのご	んを気	わざろ		hBhB tito	ろぬね	
をうう	んなたえ	12000 1 2013		を通わ	ろぬね	ジェ
をか	haha	17.000 1.3000	わかう わかる	を ううしょう あい	ろふね	う 溜 二
を滅	horder h	な変		を激わ	ろぬね	が 、
をわ	んの意思	わえう	わぶん わかう	knob	ろふね	64 20
をうわ	んあえ	ねるわ		をきゅう	ろきあ	ジャ
をう	心孩	ねまう	かぶえ われわ	杨扬	<u>ろ</u> 塗蒸	ジャ
を払ん	心流	根で	かえ わゆ	をいわ	<u>ろ</u> ぬえ	が
を加え	JAB	物怒	තාබී තිනී	んちわり	ろ <sup>企</sup> 蒸	を
をわ	JARE .	振る	かがわ わ 250	を知り	ろ <sup>絵</sup> 蒸	38
をわ	JAR	物を	bb≌b bb3b	を運び	ろぬを	he
をん	う 予 た 系	なかり	わか <u>い</u> ろ わわれ゛	を感わ	ろぬを	58
をあう	586A	わを	かう、われを	をめ	ろぬを	he
をあい	うるゑ	杨柔、	わかう われわ	を思め	B≩h	う
を認知	Jung	お数	加新加格	を邀り	ろ҈ん	ん
を着り	うたを見	杨登	かき 招迎う	を予め	ろ塗ん	うき
をわ	うわえ	ねっか	わうあ おふゑ	を思わ	ろ言う	うき
をを	うわえ	物を、	わざわれがわ	をうわ	ろ言う	ん塗
を動	JUNE	ねわ	わる 招う い	あっ	ろ言う	う選
を願	うわえ	<b>授</b> 黑 <sup>`</sup>	枷着	を思わ	3°°,	し、
を愛わ	Jang.	柏连	わかう わろわ	をめ	<b>3</b> ≙```	h
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をむ	う資気	ねなわ	动机 招狂	んろわわ	рŧВ	る
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をわ	うええ	<b>Z</b> en `	加楚 招ゐ	here	われわ	<u>A</u>
をわ	<u><u></u></u>	をあう	かわ おお	んうめう	われわ	<u>A</u>
をわ	J'ARR	子和西	තති තිබි	んごを	われつ	<b>反</b> 差
をめ	うをえ	ろい夏気	かゑ゛招願	んわゑ	われる	を
をわ	JAR.	物を゛	加乾 招紹	を濁ゐ	われる	るの
をわ	Sinte	捩ん	ねえ おろう	khhö	われた	う
ৰুক	うるんゑ	初約	加熱物酸	んろぼう	われを	ん遊
をわ	JEAR	わきり	わわう わろわ	ん意志を	われを	62 A
をわ	JE AND	わをう	动猿招物	hote	われん	ん遊
をわ	J. 10	わる	动动物	石石	われづ	<i>ha</i>
をわ	うずえ	ねるか	わわ おおわ	んわきを	われづ	る
をのう	ううな	物级	加柩扬	杨阳	われ `	62
をのう	うる	ねめ	わわわ おを	を勤	ねる	ん塗
をか	<b>う</b> 塗`ゑ	<b></b> 療施	わわ わろわ	KNAB	わる	う
を反	劉反	わゑ゛	动物 扬飞	んわらわ	ねる	んな
কার	A CON	わどわ	初动 扬蓬	heate	わるわ	64 A
をわ	శీవి సి	われを	わわ おろわ	を塗わ	わ踏り	んぼ
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をわ	in the second se	わゆ 、	かる 招格	んれうう	わろう	ん差
をわ	When the	たれん	わる われわ	を思わ	わる気	34
をわ	<b>শ্বা</b> হ	わるり	动物 机管	をかわ	わるを	ية الأ

をわ	and a	おぼわ	bbab b b b b b b b b b b b b b b b b b	ක්කා	わるん	hà
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をわ	遊友	ねむん	招格 机管	をを か	わた	3
をわ	in the second se	振わ	杨柏柏额	をかき	わた	<b>ご</b> 選
をわ	遊ゑ	物震	おろわ わねわ	をえ	わわ	hit
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をわ	<b>MAR</b>	をわ	招聽 机聽	を感を	båo <sup>°</sup>	<b>ご</b> 道
をわ	No.	かるり	招添わ わぼわ	をかえ	båo <sup>°</sup>	う道
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をわ	STR.	われん	招级机动	ん気着り	おあ	を変
をわ	۵. کو	わ	杨格 机酸	hto	わわ	68
をわ	<b>2</b>	ねる	わろわう われみわ	をかめ	われわ	ジャ
をわ	邀版	わわ	招物 机心	hniz	わわ	h
をわ	zhane	ろきわ	招格 われん	hphB	わえ	<b>反</b> 差
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をか	<b>Inn</b> à	わろう	招给 わわ	をかね	わむ	68
をか	3hada	をあ	招勁 机酸	をう	ちぬ	う
をが	বাস্তাক	协会	招怒われわ	んわるわ	<b>わ</b> わろ	ん選
をのう	子的品质	をわ	h3th the	うねまう	わねわ	わる
をわ	3hada	わぬり	招加 机酚	んぼん	われつ	hæ
をわ	3h Base	物怒	home the	んむ変わ	われわ	68
をわ	3hore	加奶	ねむう ねぬる	http "	わめつ	hit
をわ	3hter	検索を	物逸 物配	ねろろう	わ む え	hà
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をあ	Č <b>I</b> Z.	根類	<b>わた</b> わきを	んわえる	わえる	62A
をあう	<b>込</b> ゑ ※+云	3-24-5 - 7-3-3		うたを	わえつ	<b>7</b>
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を動	NATES	わ <b>塗</b> ゐ		<i>h</i> 5☆わ ご~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	わえん transi	逐
を感じ	NOT THE REAL PROPERTY OF THE P	う	<b>∤11</b> \$\$\$5 ⊅ <sup>™</sup> \$	- Tesh	わまご	われ

をを	with the	おを	<b>/ħ</b> ⊋ b ≧3	うわ	わまう	を
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をわ	nd	Mag Name	わわか わ塗゛	汤石	わゑ゛	われ
を認知	<b>う</b> 塗`ゑ	が原	わる わ 塗	石石	お柔゛	<b>う</b> え
をあ	うずえ	われ B	オれぬか わ 塗゛	わあ	わを	んな
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をわ	う変んゑ	<b>گۇ</b>	われる わ 塗ろ	んむをつ	わるろ	55
を検索	JUL ST	芬陵	オヘルの゛ ゎ 塗ろ	んうれづ	わるろ	7.2
をわ	JOR	3hto"	わむ わきろ	ゔ゚゚゚゚ゎ゛	わざろ	われ
をう	JUZ	たた	わむ わ 塗わ	ん薬	ね名	ん運
をうわ	うれえ	<u>Z</u>	われたわどわ	h Sh	わきわ	<u>A</u>
をわ	ん塗んゑ	33°5	われを わぶわ	33/13	わきわ	<u>A</u>
を涼	NOTE	ろわ	村を わきる	うわ	わをわ	26
をう	White	ねきね	われを わぶゑ	んうぎわ	わをわ	ha l
を診	ん風気	おわ	物類わどを	んをわり	わるわ	を進
をむ	NOTES	ろかれん	this the	ん変わる	わきわ	<u>A</u>
を読え	ん物気	ゎ゛	加速わざ	Knab	わきわ	<b>Š</b>
をあ	when	 ろ える	おな わ遊ご	んわたん	わきわ	を
をむう	んれた	物版	机绞 机	ත්කුව	わきわ	を
1215	ন্দ্র্য জ্ব	ろかわ	the this	here	わきわ	<u>هم</u>
んむわ	601R	ħ	the the	ん変わ	わきわ	うショ
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んわ	ANTE	ねぎ	おわわ わろう	hhiz	わゑ゛	ジ
have	র্ষ্ণকর	かをわ	the the	を通わ	わゑ゛	54
hanoj	A BAR	机图	the the	んわきわ	わえづ	を整
who have	<u>র</u> দ্ধার	をを	ねあう ねねる	hpto`	わえづ	ジ
んわ	ALZA	机路	the thick	෦ත්ත්	わえん	を整
んな気	<b>ゑ</b> 密 ゑ	わわわ	theto the	んれあり	わえん	64
んむ	<b>AND</b>	んわ	that the	ත්ත	わまた	われ
was	る塗んゑ	3bbb°	机泵 机板	うわわ	わまた	254
んぼう	ත්ත්ර	55%	then the	33 M	わ変紀	<u>A</u>
hat	みたた	ろ 讷	柏连 柏岛	ん゛	わえる	を
പത	চাইকর	ろうね	theor that	hBhB	わぼわ	を
んゑ	るのを見	超》	物物 物旋	庵	わぼり	を診
んぼう	るの意思	子的死	抽動 抽動	うぼ	わゑわ	わ選
んぽん	みたえ	ろつろう	わき、われるb	违派	われ	わぬ
んそう	石油加强	th	that the	を習り	わゑ	うな
んをわ	なる支	ろれわ	おねる われこう	<b>371/13</b>	ゎゐ゛	<u>A</u>
んを見	みれえ	わぶを	thus the	honda	わむづ	he
んあん	石村夏	おわぬわ	机、机酸	here	わわう	64
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んねり	わるため	松圈、	the thus	杨香	わま	ジ
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んわう	わちんえ	ろりねる	the's the	うわわ	わる	<b>7</b> 5 <b>1</b>
んのわ	わきた	ゔ゚゛	theto theor	うねゑ	われわ	わる
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ん診療	われた	をわ	hand that	<i>ha</i> b	わわう	われ
んごう	われた	ろりねる	おお 招格	う風	われん	<b>7</b> 51
うわり	わどを見	物的	招怒招	ん <b>逐</b> ん	わた	64
うわ	われゑ	おねる	招勁 招机`	うたを	われる	を
うれ	加强	юB	招翫 招翫	うたを	われわ	を
うる	ねる	招加	动物 招致	んえいを	わわ	を塗
うるわ	松原	53mb	තින් තින	んぼう	わる	<b>A</b>
うぼん	われた	ろを	招捷 扮嬌	たきん	わわ`	を
うわ	われた	わS <sup>®</sup>	ත්හි තිං	んねの	わわう	he
うわ	われる	おかわ	おね おわ	んわぬわ	わわ	んを
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うわ	わまえ	Ш.	扬扬 扬扬	John "	わねる	われ
うわ	われた	子的石	杨阳杨颜	ろれる	わわ	われ
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Sah	われえ	加额	招気を招き	んをいう	ත්තිට	を整
う瀬	われえ	加奶	おわれを	んうきわ	わ変を	んな
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うれ	ふ液	ろう	おあん おう゛	<u>36</u>	われづ	を
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うわ	325	නත්	杨洵、初初	ろめ	われわ	<b>A</b>
うわ	322	Zen "	おうろ わろわ	动物	わ	<u>z</u>
うう	3212	物物	おうわ わを	んを柔	<b>3</b> ☆``	Ka
うわ	3222	52.65	杨康物感	んわちう	_ ろ☆ゔ	<u>A</u>
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<b>Шр</b>	3000	を感じ	おき われを	Jalah	ろ塗ろ	わぎ
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<u>通</u> わ	3.12	300000	the the	う <u>う</u> き	ろうわ	72
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<b>а</b> сь	3.	子如野	わわわ わかわ	3nBh	320	₹.
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<b>塗わ</b>	3868	রাত্য	the track	うかわ	325	われ
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∛20h	Sinte	ろを	the the	んを習り	ろあわ	を
₫¢h	States	hB® <sup>°</sup>	わぬわ わぬる	んわきを	ろ落わ	ん
う	Store	ろわわ	わゆう わめえ	hhào `	ろ落つ	තියි
う	Sha	石山原	the that	hita	ろきわ	<u>Z</u>
зъ С	3000	お影	わわわ われう	んむきわ	ろをわ	ん北
ЗЪ С	3.000 S	තාවේ	动动为机	うれるわ	383	<b>∂s</b> ≙
∛aab	Sha	<b>塗っ</b> わ	动物"杨路	れた	383	わる
<b>逃</b> わ	ろわえ	<b>Zptz</b>	these the	<b>33</b> 00	ろを	<b>7</b> 34
<b>踏</b> わ	ろわえ	AD '	われたわせん	ろね <sup>×</sup>	ろを	わる
<b>MAR</b>	State	んゆう	わぬわれる	5536h	ろを	われ
<b>MAR</b>	STOR	ろかを気	かすわれて	33/13	ろゑ <sup>°</sup>	754
State	State	をおわ	物驟 物發	れらう	ろゑ <sup>*</sup>	われ
あ ゔ	State	わぬわ	物题を わるん	わぬ	ろゑ <sup>×</sup>	34
<b>通</b> う	3	んわう	われんわろう	ろめづ	ろゑ <sup>×</sup>	わ差
۲ ۲	3	ろおう	ねゑゔ ねる゛	透影	ろぼう	わふ
資わ	马纳桑	30tri	物象、物物	うわわ	ろぼう	る
資わ	300	ろうわ	わを われる	んを図り	ろぼう	を
塗り	ろわえ	杨超	かる わねる	෦ත්ත්	ろぼう	う
愛わ	Same	うき	わをわ わわわ	んむねる	ろぼう	わき
₩ Mar Mar Mar Mar Mar Mar Mar Mar Mar Mar	3035	ろ金を	わわざわ わかわ	化版	ろぼう	<u>Z</u>
塗し	Sala	ろうえ	わかおわ わかわみ	ろめ	ろぼう	<b>73</b> 2
塗し	ろぬゑ	ろわわ	物弱 物源	うちろん	ろぼう	<u>A</u>
愛 ジ	Share	Zotal	物類 物類	うか診わ	රුවර	තිම
ぼう	SUSE	动怒	物類 物蛭	人就在	3 <b>2</b> 5	<u>A</u>
遊	3000	ろ瀬魚	加速力加	施招	3 <b>2</b> 0	を認
遊	Same	3 <b>ề</b> ơb	the third	haත්	3 <b>2</b> 0	を認
通わ	ろわうえ	经济	わあん わわう	んどう	පුණ	<u>Z</u>
) 塗わ	ろぬえ	わる	加蒼 わか゛	んぼう	3 <b>2</b> 5	ん通
) 塗わ	Sana	ゐ	动态物物	うぼう	3 <b>2</b> 0	34
<b>塗</b> わ	3 <b>8</b> 50	加奶	动态、初如	透扬	ろゑ <sup>×</sup>	を

塗わ	<u> এ</u> জুব	ろれ	加盔、	toto	んごを	52 ×	を
適わ	SALA	ろんろう	われ	物格	んみっか	ろゑ <sup>°</sup>	を
適わ	S AR	ろんを	われ	the	をあ	ろゑ <sup>°</sup>	を
適わ	3 <b>2</b> 52	ろ、願	加奶	the	h 🖾	ろゑ <sup>°</sup>	A
適わ	322	うを	加奶	わわ	うれる	3æ	わ塗
適わ	ন্দ্রছ	かむ	わねる	物物	んをれる	ろを	う
適わ	322	hth	わかれわ	わね	うかの	3æ	ね
適わ	<b>3</b> ইচন	th	われわ	わね	を塗ね	333	١. Marine and the second s
適わ	3373	ろんうわ	われわ	物類	<b>Ina</b> b	333	A
適わ	3.200	Shan	われわ	物類	うため	333	みを
透わ	350	5	われわ	物腔	h 🖥 h	ろきわ	を
透わ	SAME	ろの意	われわ	物腔	ん戦る	ろきわ	க்
遊	马机泵	ろを	加加	初轮	んぼわ	ろきり	<b>7</b> 2
遊	Shiz	わきを	われる	物物	化和西	ろ落わ	60
愛 ジ	马脑索	ろはわ	加加	初轮	加招	ろあわ	<i>Б</i> а
塗む	ろれゑ	3haz	加級	わめ	うかうづ	ろあわ	わる
₩ N N N N N N N N N N N N N N N N N N N	<u>5</u>	<b>否</b> れ`	加級	わめ	うわわ	ろあわ	<u>A</u>
) Maria	3 De	否办	加級	わわう~	きんの	3	<b>7</b>
塗り	শ্ৰন্থ	否办	加級	わわう	きお	3	<b>7</b>

	村尉心村营									
I IХ́ЦС́от	±1+-n/13v241b1/L⊺∨	wibntbi⊑tv	oπ Ti <del>v</del>	∶ीЦ∱ऀ॑ऀॖऻऀЦ	- Іфіцьт	<sup>1</sup> т % добо Цот	9↑ЏіӣҞ҄ЦҴӷ҈іѦ҄ҴӸҲ			
{IX/3	t∱тд©йжфЦйЫХ	ѡЦѻ҈҄҄҄Цҋ҄ӸҲ	×i ⊥ 1X	ILIIYLI	- τωμρί	оΙХ'т∐‡ΊΧ	ѹѿӹๅҳҴҋ҈Ц			
ⅅⅎℷ℄ℾ	ΙI	а W/Ш わô00Ц	а⊄ши∕	аЦ≒и∕і	Ξ	IŴ	ΙI			
译わ	Shh	ろをねる	物靈	ねるわ	khão	ろきを	を			
۱. ۲	ろう	相範	物靈	ねる	hBito`	ろきを	h			
3 and the second	ろうわ	the B	物影	ねる	ん猶ろ	ろあん	を強			
WER.	ろを	ろ <b>ề</b> ab	物影	ねる	ん資源	ろをう	を			
3 <b>1</b> 20	ろう゛	Ŭ¢ <b>₹</b>	物影	杨聚	れの	ろをう	わる			
<b>iii</b> ah	ろきわ	5 kg	物類り	杨骤	hanth	ろをう	を整			
й Ю	ろぬを	55735	物類り	杨骤	んねまう	3æ <sup>*</sup>	を			
₫ <b>c</b> h	わ	ろもで	物類り	杨骤	うわわ	3æ <sup>*</sup>	<u>A</u>			
塗わ	われる	3 <b>≩</b> 16	物類	杨琏	hh	Sh	を			
∛ach	われづ	ろうそろ	物類	杨琏	うかわ	343	みき			
<b>塗</b> の	わるわ	颈旋	物動	杨琏	hbab	Sha	<b>A</b> S			
ù đại	わるを	55% °	物動	杨琏	htalu`	ろわわ	を選			
1 1 1 1 1 1	わわ	thti	物顯	ねるわ	化验验	ろわわ	を			
Ů <b>∂</b> D	われ気	机疮	物醉	杨玉	施級	ろんわ	を			
ÌЗ С	わ <sup>3</sup> D <sup>×</sup>	ろ 遊気	物乾	杨劭	んをき	ろんわ	を整			
<b>逐</b> わ	わねつ	われん	物動	杨劭	んわわ	ろねつ	ん通			
ي بي	かの	<b>उ छेट्र</b>	物動	杨玉	ん塗ん	ろね	を			
<b>21</b> 60	われつ	んうう	ねあう	ねるわ	57000	She	わき			
塗わ	わわう	ねとろ	物麗 "	ねるわ	·ろわ <sup>×</sup>	ろんを	を			
*	わぼわ	机石	物震	ねるわ	んた	ろんを	を			
うふん	わえづ	ろんわり	初を	杨劭	うちをわ	ろんを	<u>A</u>			
うわ	わきり	おめ	初を	ねあう	を図わ	Shh	ん通			
うど	わをう	物额	物怒	ねあう	htala "	ろんづ	ん			
うずん	われる	おれるう	わぬわ	ねあう	hbesh	ろんづ	ん北			
うぼわ	われ <sup>、</sup>	ろうぼわ	物物	杨劭	んねまう	Ξħυ Ň	を			
うず	わる	thes	物物	杨劭	৸ঠাক	Ξhu Ň	ん通			
うれん	わ塗゛	ろを	物物	杨劭	んちあん	Ξħ	を			
うどわ	抱意	ろきを	物额	杨劭	をごわ	ろう	を選			
うる	われ B	おわ	物類	杨玉	khaz	33	ん選			
うあん	120	ろ <b>塗わ</b>	物を	杨劭	んむわ	33	を選			
う酒り	わ遥わ	ろうろう	物動	杨劭	khão	33	を強			
うぼう	わろう	ろわ	わもう	杨琏	hBhB	ろうわ	を			
う家	わねる	わわう	ねあう		んえいわ	ろうわ	を			
うぼわ	わわ	ろきね	物を゛	杨琏	予約	ろうわ	を			
うるづ	わた	th/B	朸ん	杨琏	んをおろ	ろうわ	を			
JAR	わぬわ	おいろ	初ん	杨聚	んろふを	ろうわ	ん <sup>論</sup>			
うぬか	わめづ	お家	构名	杨聚	るない	ろうわ	h			
うめ	わ願い	ねぎ	われわ	ねる	hter	ろうわ	ん社			
うた	わち	ろう	わぬわ	ねる	んうざわ	ろうえ	を選			
うわ	わた	わうわ	わぬわ	ねるわ	をきわ	ろうえ	3			
うめ	われる	招格	わね	ねるわ	んれづ	ろきを	ん			
うえ	わら	ろいれる	わぬ	ねるわ	うかめわ	ろを	₹.			
うわ	わわ	わる <sup>、</sup>	抱臉		ねろろう	ろを	h			
うぼう	わぬわ	わわう	抱臉	ね怒	んわれる	ろを	ん選			
300 N	ゐ	わち	わを	杨图	<i>h</i> 32≌ъ̀	S	hill			
うるわ	みれを	ねこ	朸約	杨昌	honth	Sh	ん連			

		_ ~ *				
うれび	みぼり	招發	招加 招加	hBrB	පත්	ん選
うため	ଅନ୍ୟ	おわめ	わわう わかう	hb	පත්	64
うわ	toth	ත්ති	物的物	たん、	පතා	64
んぷう	みわ	ろかわ	物的物质	うわめ	පත්	えば
ん◎ゑ	ත්ත	ろりた気	物心、物和	hani	ろうづ	るを
んぷわ	おわ	わち	物心、物物	を逐ん	ろう゛	るの
んうう	み変わ	ねの	わう われわ	を加え	<b>3</b> D`	う
http	るある	わね	物药物物	んわれる	3D) *	h
んぼう	ゐあう	わを	物が物格	んわれる	35) <sup>*</sup>	ん選
んち	ると見	ろやわ	ねずね	Ber	3D *	<u>A</u>
wah	ゐる	わろん	物語物》	を習り	<b>B</b>	ん選
んねゑ	<b>ゐ</b> ŵ``	杨杨	ねる わかう	んゑれる	<b>S</b> ☆`	621
んねわ	ゐ゚ん	颈旋	ねるねを	んわぼう	<b>S</b> ài	<u>A</u>
んをう	ゑね	おあ	物路 机滚	んわれび	<b>S</b> ài	ん
んあん	A B	3Ť	わる わる	んえもう	<b>Š</b> ☆	を
んをわ	කුෂුට	物药	わっか わかわ	を剃び	ろきろ	うき
んをわ	<b>AbA</b>	ろ蔥゛	ねっか わぶろ	をあ	ろぬろ	を
んそう	ゑわり	お酒り	ねあわ わらう	handen	ろぬろ	を
hãh	яd	the "	ねむ わう	んむをわ	ろきろ	を塗
んぼわ	ALL.	物源	わかわ わた	んろきわ	 ろ☆ろ	を塗
ん愛わ	2.20 2.20	おろう	物质物质	horen	 ろ☆ろ	を塗
പര്	桑奶	ねむを	おう わうわ	hphz	ろぶろ	う
hitte	RÉ	1300 C	わらわ わらろ	んぼう	ろぶち	を塗
Nate	<u>A</u> LA	お迎ろ	おかわれ	んれる	<u>ろ</u> 塗ろ	<u>い</u>
hab	and b	杨震	わらう わらう	を知る	<u>ス</u> ろ塗ろ	3
hitto	AD '	旗招	わらう われを	hnzh	<u>ろ</u> 塗ろ	が う ぼ
1.100 Marini	えきを	物》	おろ わぬ	ん気をか	<u>ス</u> ろ23ろ	62
1.4000 1.4000	~~~~ C	33	おろ わぬ	hatos	<u>ユ</u> ニン ろ☆わ	703 を図
640	をあ をあ	わ	招遊 わぬ	knab	ろきわ	62 102
http://www.alice	を変わ	132	お話 わだ	/ を <sup>*</sup>	ろぬわ	3
hato	<b>を</b> わ	初超	物路加糖	htp	ろぬわ	<u>人</u> 通
/ଧ୍ୟୁଚ୍ଚ /ଧ୍ୟୁଚ୍ଚ	をわ	1月20日	初35 初36	だ	ろぬわ	33
hith	をか	1 かる か わ う か	おお わぬ	を挙び	ろれる	ん遊
んわ	をむ	555	初気 わを	6112b	ろれ	を越
hitop	を愛	加密	1320 1320 1320	あっ	ろれる	
hào	で あ 変を	ねって	相応 加速	を を を	ろれる	ス 33
h SS	をむ	イルーズ ろ 塗り <sup>×</sup>	相応 加配	ANTO	ろれる	を
heen so	を遊	the b	相応 相応	を塗ん	ろれる	hæ
NER	を読え	る過考	1320 13200	kin2tan An2tan	ろれる	を
んぼわ	2000 2000			んご あわ	うぶわろ	hža 1
	感か	わねん わろんづ		んねる		1024 1028
h⊠n h⊠s					ろふわ	
	をわ	杨莲		を激われて	ろぶわ	
1215 1210	を <u>塗</u> う んれる	たわら	おれづ わね せかぶ せかやご	<b>を</b> 塗う	ろ☆わ ろ☆わ	づき
han han		おかれん *******	おかう わかう せからう せかかち			
んなた	han °	物象、		んわれで	ろきわ	6 <u>1</u> 2
hato hato	here have	ねん		んれaeを	ろかわ	が
hans k	hào Mao	わむし	物化 物路		ろきわ	ジェ
ん	hite	われ	おれん われづ	んればわ	ろきわ	ん遊
をう	hato	物を		hhat	ろふわ	
をふん	んれを	物额	物をわわ	んわざわ	ろわ	hà

を読	hits .	ねる	物短柏地	කින	ろ塗わ	38
をわ	hold the	根を	物類 物彩	をぬめ	ろきわ	う道
をわ	んゑ	动动	物的物质	んわわ	ろきわ	うき
を診	ん変象	わ3B	おれる わぬわ	石石	ろゐゐ	ん遊
をうう	んゑ゛	ねねう	わぬわ わろろ	ちずわ	ろぬあ	う
をか	んあっ	根跟	<b>おかわ われご</b>	ぢ	ろぬわ	う道
を気	んをう	なる	物物 物源	を濁ゐ	ろゐゐ	58
をわ	んねわ	わえう	物路 物物	khab	ろゐ	hà
をうわ	ん酒を	ねるわ	われ わ	をきわ	ろゐ	58
をう	んう	ねめご	わを、わぬん	をある	<u> ব</u> ুহু	う
をん	hote	反応	物を、わぬる	をいわ	ろ☆ゑ	33
を検索	රුණ	机路	わをう わぬわ	んちわわ	- স্ঞই	ん
をわ	ん塗わ	杨阳	物勒 物感	をわ	ろぬえ	う道
をわ	ん塗蒸	物を	物链 物迹	を塗う	ろ絵を	ん絵
をん	<i>h</i> ≜``	ねめ	物類わか	をあっ	ろ絵を	う達
をもう	うわ	わを	わぬわ わかう	をお	ろ金を	hil
をあ	うを	物震	物物 わん	を認め	ろぬん	58
を認め	Jan "	杨薇	物药物源	を邀り	ろぬん	6
をあり	うどろり	杨苍	わを わぬわ	を予め	ろぬん	3
をあわ	う変を	ねっか	物质的物质、	を思わ	ろゆう	5%
をを	う <u>あ</u> ゛	物卷	物動物	ちょう	 ろ☆ゔ	3
を変わ		たわ	物類わり	あっ	ろ塗う	3
を願い		<b>按</b> 梁 <sup>°</sup>	わめわた	を思わ	 3≌ <sup>°°°</sup>	し 
を愛わ	36	物签	物動力動動	ත්ත	 3逾``	~ ん選
を 変わ		初ん	物象わえ	khta	 わ	6 <u>%</u>
を柔	34A	われで	わめう わえ	hing	わ	1. 1.
をむ	うず	わむわ	わた わめう	KINESS	b≱B	. <u>…</u> ん遁
をむ	330	わかわ	初动 わめ	hadab	bt B	ん <u>逸</u>
を読み	5340	扬扬	初始 わる	1210	か <b>わ</b> わ	6.4 1
を踏わ	う 波を	Jan	わめ わめ	施液	われわ	
<b>を</b> ぬわ	う あ 、	<u>-</u> ත්තෝ	物物物物	んうわう	われわ	<u>A</u>
をあ		ろんれる	the the	んごを	われわ	<u>z</u> i
をあ	J.	ろの変象	おなわ わた	んねゑ	われる	を選
をか	300	物を	初わ わた	を濁わ	われる	hù
をか		杨	おむ わむ	Khhö	かれた	33
<u>କ</u> ୋଜ	<u> </u>	初始	初级 加强	1220	われを	hile
<b>を</b> わ		われた	おかわ わを	杨融	われを	101 101
<b>を</b> わ		わどう	お返 わめの	んかえ	われん	/u=
<b>を</b> わ	うばわ	わがる	the that	るあ	われづ	ん <u>通</u>
をわ	う))を	17250	おろわ われを	んねきを	われで	104 104
をめ	35	村2000	おろ われわ	/a	12-0 われ、	10 <u>8</u>
をめう	うぼわ	132000	招迎	を勤	わろ	ン。 34
をか	う う を	根旌	われる おきを	kh4z	120 わ <b>死</b>	ジャ
を検	<u> う</u> う `	わた わた 変	おお おむ	hter b	1 <u>2</u> 2	
を反	うわ	わがわ	1320 1201) わかう わかう	heate	わるわ	/02 /02
をわ	うきを	が遊	かぬ 招致	を釣り	わざわ	/04 /04
をわ	ے بھر ×	13.200 ろをわう	わぶろ わろうわ	-2 <b>*</b> 37 1-35	わるわ	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
をわ	塗わ	ちき おゆ゛	わらう 1550 わらう わらう	Anos	わ <u>あ</u> わ <u>あ</u> み	hite
を あ か	± €	1320	かる おん	を図り	わるの	
<u>ක</u> ො තිහා	¥60 ॲ	かどわ	わぶる おかわ	を を か む	わた	ير تغ
. CHAD		1 1 1 2 2 1 1		~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	1252	

をわ	×	おぼわ	动物 扬	ක්කා	わろん	3
をわ	3	732 ろ <b>逐</b> う	かぬ 招も	3hab	12370 わめ	秘
<b>を</b> わ	 13000	25-25) 25-36)	初纪 招扬	kbkb	わる゛	<u>A</u>
<b>を</b> わ	No.	振荡	物新扬客	ත්කුව	ねる゛	ジェ
をわ	± 20°	おねわ	かもおい	を運	わわ	hà
をわ	*** *** か	物选	お魚、招願の	をうぬわ	12 12 12 12	hà
をわ	<b>遂</b> か	物卷	物乾 招配	khab	わわ	h
をわ	36	初知	われた おろう	KNAD	わわ	6
をわ	No.	动场	物が招援	knize	わねる	<u>A</u>
をわ	Ì۵ کی	ねむん	物级物理	ten "	わた	ば
をわ	<b>愛わ</b>	振わ	初超 招知	をかき	わた	う道
をわ	逐步	物黑、	われん 招格を	をえ	わわ	h
をわ	遊	ねを	わわる わろわり	んれぬわ	わわう	う選
をわ	<b>26</b>	をわ	わわ わろわ	を認を	わ <sup>a</sup> o <sup>×</sup>	う
をわ	) E	かるり	加症 扬动	ないた	わ <sup>a</sup> o <sup>×</sup>	う
をわ	àЗ	toos `	わわ おみ	んわれわ	おあ	3
をわ	MAR.	われん	物圏、物理物	ん感わ	おあ	を
をわ	通び	わ	加强、扬飞、	hb	わわ	んぼ
をわ	<b>B</b> B	ねるう	初路 杨琏	をおめ	わわ	う達
をわ	2 <b>7</b>	わわ	われら おろわ	kning	わね	68
をわ	۵.	ろきわ	物源 扬码	hphB	わた	<u>A</u>
をわ	<u>`</u>	ろ 逐	加招招的	を勤	われを	を進
をえ	<u>هُ</u> نُ	ねめ	おう おを	んかき	われん	を
をえ	<b>塗</b> ゐ	ろどろ	超ぬ 招加	を゛	わめ	を
をか	<b>塗を</b>	わちる	超3 招格	あれる	わ <b>わ</b>	ん道
をか	塗ぎ	たる	扬鲂枷	කිා	わね	33
をの	<u>گ</u>	物感	招頭 机乱	hbab	<b>わ</b> むろ	ん遊
をが	Sharb	をあ	招話 ねゐ	うわえご	わぬわ	わる
をわ	Sharb	物類り	おんづ われわ	ん塗ん	わぬわ	64
をわ	Shinb	物名	杨頫 物"	んむ変わ	われわ	ん運
をわ	Shinb	动的	招袖 机55	khab "	わねつ	hŵ
をわ	Shinb	検索を	招き、加速	ねろろう	われた	う
をわ	Sharb	わかわ	招楚 机动	んわまを	われた	ん差
を検索	3h	<b>热</b> 滚	おもわわわ	を衸	わるか	う
をわ	×***	ねる	招连 机路	んわれわ	わわう	34
をわ	<b>塗</b> ん	ねる	招致 机心	んねきを	わわう	ん進
を	<b>塗</b> ゐ	物意	招願机	あんめう	わぬ <sup>*</sup>	hà
をわ	<b>塗</b> わ	the	hose the	khab "	わゑ	を塗
をむ	<u>ک</u>	たる	杨尚、柏婉	をを	われる	透
をむわ		杨灿	扬扬 机石	をきわ	わえる	38
を踏わ	گن ک	たむう	招动 わぬり	を思わ	わえり	通
を設め	业在	<b>塗</b> を	han hha	theth	わぼり	わぬ
をか	àЗ Х	根板	$h_{20}$ $h_{10}$	<i>k</i> わ愛わ	わえる	62 
をむう	it is the second	zdato	招助 加查	うたを	わえる	738
を柔	遊	ねねう	招级机管	khizh	わ願い	hila
を愛わ	<b>愛わ</b>	おむわ	招約 加若	khao "	わた	618 - 11
を愛わ	ĭanton Naria ĭ	わ∕ŵわ	Hours that	んねきを	われた	ジェ
を願	<u>گ</u> ون ۲-	hhalu <sup>°</sup>	home the	を濁わ	お願か	<b>ジ</b> れ
を動	<b>≧</b> 20>	わ <b>塗</b> ね	how the	んろ塗わ	わえん	う
を感じ	う	う	招短 机额	-Jean	わまう	わえ

をを	کلوکی	おを	扬扬 机额	うねり	ත්වේ	を
をあ	潮を	ìр Г	招助 机额	うかねっ	わゑ゛	われ
をあり	うきを	Mag Nag	招招 机药	汤奶	わゑ゛	わる
を認	うを	方類	招怒、加ゐ	的感	わゑ゛	54
をあ	うた	われ B	招盼 机翻	んわあん	わを	ん選
をおう	5×25	扬速	招班物动	KNAZ	わを	ん塗
をわ	う源泉	th	招發物類	を塗わ	わちろ	ي ت
をわ	<b>3</b> 00	<u>ک</u>	招勁 物類	んむぼわ	わきろ	る選
を検索	うわ	芬选	招致 物藏	んうで	わきろ	<b>7</b> 54
をん	うる	Shto "	扬扬 机额	ゔ゚゚ゎ゛	わざろ	わる
をう	∋n°	<b>授</b> 校	hore the	ん塗	わるろ	ん遊
をうわ	ん塗を	<u>S</u>	招怒物机	ん <b>迷</b> ん	わをわ	<u>A</u>
をわ	んえる	555	扬扬 机勒	33/13	わをわ	<b>A</b>
を演	んねろ	ろわ	招怒机怒	うねわ	わをわ	<b>75</b> 2
をうう	んゑ゛	ねむね	招怒力施	んうわ	わをわ	ん選
を診	んのを	招加	h3n° hha	んをわり	わをわ	を
をわ	んねつ	ろかれ	han tha	ん変わる	わをわ	を
をきえ	hito	ゎ゛	h3n° hnab	knnb	わをわ	<b>Ž</b>
をふん	when	ろ 瀬ね	招机 hhab	わあん	わをわ	を選
をう	をゐ	机原	扬机、机石	んみまご	わをわ	を変
han b	ක්	<b>ろか</b> が	招怒 わた	heto	わをわ	<b>75</b> 2
んれつ	をあん	th	扬扬 われん	ん変わる	わをわ	<b>Ž</b>
han	をあ	3h/u `	招怒物心	んなわ	わきろ	る選
んれつ	をある	ろきを	招怒 物写	る診ち	わちろ	ā.
hB	をおう	ろを	hash this	hha	わきろ	を選
んぼう	を変め	<b>Zh</b> S	招致 机动	heate	わきろ	Jak
な変象	をむわ	ろうの	招码机连	子和	わざろ	<b>7</b> 34
んそう	<b>A</b>	5360	招级机动	逄	わを	わる
hito	ゑねん	33 d	杨链柏	うかえ	わを	<b>7</b> 5 <b>1</b>
んわ	<u>a</u> ta <u>a</u>	ねめ	招歌 机浴	hhite	わゑ゛	54
hite	気気の	かわ	超過、打心る	を踏り	わゑ゛	うき
んもう	<b>A</b> B	机图	おわわれを	んわきわ	わえづ	を
hito	æ¢o `	極を	ねむわ ねいう	hter	わえづ	58
with	ක්ෂා	机路	招助 招格	රයා	わえん	を
んた	ゑれを	わわ <sup>3</sup> ch	おをおわ	<i>k</i> れ	わえん	60
んちう	る◎蒸	んねつ	招助 招枪	んうめう	わきを	われ
hito	ಡಿತ್	ろわね <sup>、</sup>	超れ、招机、	わわ	わまた	738
んぼわ	みれわ	动机	超极 扬弼	35Th	わ家	<b>A</b>
hat	み通わ	ろ 讷	超物 招勁	ん゛	わえつ	を
hat so	みぼわ	ろうね	招校 招航	杨祝	わぼり	を
んゑ	みぼう	bB☆゛	ත්ති තිං	庵	わぼわ	んな
んぼう	みわ	子的原	おる おわ	うれび	わえわ	わ差
んぼん	みわ	ろわろう	おわれた	违领	われ	734
んぼう	ත්ෂිත	扣	杨旋杨物	を習り	わえ	<u>`</u>
んをわ	<b>D</b>	ろれわ	ත්රා ත්රා	<b>TNA</b> 3	わぬ <sup>×</sup>	<u>z</u>
んたえ	わきを	わぬを	招影 扬枝	んうねわ	わわう	64
んあん	わらん	わぬわ	おわねか	herbu `	わわう	ha ha
hitu	われ、	わめ	招發 招助	んうむわ	われを	ん
んねつ	われ	<b>松園</b> ゛	杨震、杨雄	杨路	わるを	<b>う</b>
hah h	わきわ	ろ 塗わ	招翻招了	予約	わる	を

んわう	わえる	ろわれる	お類相動	うわわ	わまる	201
んちゃ	初步	<b>う</b> ゜゛	扬勃扬克	うね	われわ	わる
んえ	わわ 、	Shink	杨柏 杨卷	うふを	わる	わぬ
んう	わわ	<b>ろ</b> れ遊り	おわ おあ	うぼわ	わね	わら
んぬわ	わる	35巻り	招旌 招彩	うれの	わわ	わら
んぬえ	わめん	をわ	杨灿、杨炳	that h	わわう	われ
ん心う	わる	ろりわわ	扬动扬风	うえ	わわ	る
うわり	わわ	物的	杨薰杨心	h 🛮	われを	ん生
うわ	ねを	机动	ත්ති තිබේ	うたを	われる	を
うれん	わ゚゛	扬扬	超沽格動	うたき	われわ	を
<b>う</b> る	わわ	扬动	<i>ත</i> ුක තිබෙර්	反診を	わわ	ん
うるわ	われん	53mb	超ん 招流	んぼう	われる	<b>A</b>
うろん	われ	ろを	わわ 招強```	たきん	わわ`	を
うわ	わるわ	bb⊠ `	total total	んねのう	わわ	62
うわ	わえづ	おかわ	物源 物机	んわぬわ	わわ	hila
うわ	われ	ねあ	われう わろろ	んわれる	わた	ん北
うわ	われる	ШЪ	物题物题	Jah "	わねる	力生
うわ	わわ *	子的石	わる わる 、	310	われわ	松
うれん	わわ	子的在	かをわわ	hhitu "	わわ	<u>A</u>
520	わめ	 わむわ	初近的	の通	1210 1210	62 102
うぼわ	わわ	われん		n	わる ~	ん主
Jan Jan	わるを	加額	わゆ わを	な塗わ	わめう	を払
うえ	わ <u>あ</u>	加奶	the trac	んうきわ	わるを	6 <u>8</u>
う 通わ	が原	わらわ	われ、わぬる	1021	123C	極
Jan Jak	32°°	Shahb	かね わむ	うう 家 か 多 か 多 か 多 か 多 か 多 か 多 か 多 か 多 か 多 か	12mm わろろ	し、
うを うを	 ろ塗ね	ユ <b>ユ</b> む 塗わ	わね わえ	55476	わろう	わえ わえ
<u>う</u> 適わ	<u>5</u> 5	<u>■</u> 70 ろ <b>塗</b> 加	われ わき	1524 La	12 <u>5</u>	を
う <u>あ</u> ん	පත	う 35枚	わむ わを	-1120-	1 <u>3</u> 20 わろ	<u>A</u>
540	Stu <sup>°</sup>	<u>しょ</u> い ろ <b>変わ</b>	かる わめ	332	1 <u>2</u> 2	~~~ を
うわ	<u>ろ</u> たみ	う <u>第</u> 約	わる わる	し、ううない	われ	を認
5400 5400	Jan Star	30200 30205	かを わる	ん塗わ	われを	<u>A</u>
うろう	330	- Shilles	かる わる	10 × 10	われる	A Contraction of the second se
づう	32	-30000 -300035	$\frac{1}{100}$	ん認知	われつ	を認
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づか	3 <b>2</b> 5	-5500 Zen	加索加強	うわ	1243 (F) わ	21 21
<u> う</u> あ	5mm	- 2011	h = h = h = h	な感	⊅ 3≌``	60g
ごわ	<u>う</u> ぬり ろぬわ	TA AND TAB	わえ、わどわ	//過来 んわれのう	うぶう	704 桑葚
乏わ	- Star Star	- 5400 わろをう	加速 1かれ	を塗わ	ろぶを	ha ha
えん			わざわ わ		<u>স</u> ুদ্দ স্ট্রা	700 ゑ1
	3100. 2107	ろりをわ **		khost khost		×4
ゔ゚ゔ	3435 20	わ N	物類が	hter h	ろきね	
No.	310 70-3	う <b>え</b> わ まそご	わるかわれ	んんあん	ろきわ	ねる
<b>塗わ</b> わ	3400 7400	を見づ	わをう わる		ろ塗ろ	われていた。
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й Э́л	32h	<b>5</b> 願	わかれる わかわ した またのはち	んか あわう イス まえる	33) 737	を
<b>8</b>	350	<i>S</i> ≈	われを われわ	13000 ×	ろを	20
逐わ 淡古	<u>ろ</u> ろわ	ろを	houte the	人意思を	ろう 交 え こ	70 70
どう	<u>ろ</u> あ マ4つご	ろうわわ スレッチ		う <u>う</u> ろろわ こ	ろうわ ろうわ	<b>み</b> 塗
۲	3400	ろんなを	初33 初33	3nni Anni	330 70	₹ T
) Kar	ろれを	ろ 資わ	わるわ わねる	んうざわ	ろうわ	を

逐か	Sta	ろうろ	动动物	んうきん	333	を
ث ک	340	ろんで	加速 物如	hand	ろう	<b>R</b>
Ů <b>∂o</b>	ろわり	ろ 逐わ	わっうう わかわ	んわえう	S‰`	を進
Š <b>∂o</b>	Sinh	ねろろん	わっう゛わかゐ	んる総わ	ろわう	he
∛abb	34B	30座 "	ね塗ろわぬん	うかろう	ろんを	み差
うわ	3	ろかろ	わぬわ わぬ゛	うかうう	ろを	Ъk
<b>塗わ</b>	3	ろ遯ゑ	加給わる	のた	ろねつ	を
₩₹.	3	をきわ	わぶを わぬみ	をする	ろねつ	<u>A</u>
ền/u	3	30%hb	ねかう ねを	和新	ろんわ	る運
ền/u	3	ろかう	加減が加速	んわまを	ろれわ	<b>A</b>
В Ю	3	55m	物格 物卷	わう	343	を
う づ	3	ろ心わ	われら わたわ	动质	3h	<u>A</u>
ð	3	ろpiを	物的 物药	33h "	3æ *	73
も	34B	をわ	物源物题	んを おう	325	3
∛a⊅	3th	子如子	动物 物物	Then	325	æ/
¥ср	340b	西方	物的物质	うを	 3261	<u>A</u>
<u>潮</u> わ	340	<u> 柔</u> の	物路物路	Total	325	わ生
<u>柔</u> わ	340b	ろんのあ	お死 わぬ	hita	325	を巡
*** ***	3402	53	おをわ わえる	1515 1515	3	翘
₽	3th	う か わ わ	初始 わぬ	を塗	360	
*~~ *~	3th	12年1	招援 わぬん	を塗わ	360	を認
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<u>ま</u> の	540 Sta	3020 Spt0	初50 11100	hhito `	う <u>き</u> ろをわ	70ය උතුදු
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й Э́р	38 797	<b>30</b> 00		hts 17:55	ろきわ	
320 201	335 7370	た 死 ろ	おなる わかわ	んむざわ	ろきわ	<i>h</i> ∕≊ ≂≁
کھ سر	ろ <u>あ</u> わ	<b>30</b> 200	おわわわ おわらわ	3hab ⊅∞≠	333	ā.
∛ab ≫ab	3330	<b>踏</b> わ す::::::::::::::::::::::::::::::::::::	おおわ わかる	うたき	333	わる
	335	ろわれる	物液 物透	350ab	ろを マー	<b>7</b>
	325	AD '	物旋物的	3hu î	32	わ選
W.S.	SEW	hitos	初始 物药	553h	3 <u>5</u>	われ
MAR.	335	ろりを気	おかう わかう	33/13	<b>ろ</b> ゑ <sup>*</sup>	<b>Bet</b>
3 an	30	をむ	おか おか	れの	3æ í	われ
	343	わるわ	おわわ わかろ	わぬ	3ª	31
ど う	ろわ	んねづ	わな わぬわ	ろめ	32e î	われ
۲	ろわ	<b>35</b> 15	おなわ わぶわ	うきめ	ろぼう	75
塗わ	ろわ	Shapi	わわわ わかる	うわわ	ろぼう	<b>7</b>
塗わ	310A	55 <sup>15</sup> 10	物物 机流	を習り	ろぼう	を
塗り	ろを	物路	物類 物效	ත්රා	ろぼう	う達
塗り	ろわ	うき゛	わた わぶを	んむむし	ろぼう	わた
Ĭ₩ N	ろめ	ろぬを	动物 物论	んぬえ	320	<u>A</u>
愛わ	3do <sup>°</sup>	ろうえ	われわけ	ろめ	320	ക
愛ん	30	ろれわ	物矿物沁	うかろう	රුවර	<u>A</u>
ぼ う	33	Shah	物物"机"	う診わ	රුවර	734
ぼ う	3tob	动怒	物物物物	んなを	ろぼう	<u>A</u>
遊	ろわり	ろ瀬魚	物为物理	施品	ろぼう	を
遊	ろねつ	3 <b>ề</b> ph	物奶肉物奶	ねつう	320	を選
通わ	340	经济	物级 物物	んどう	320	<u>A</u>
塗わ	马校	わる	おぬわ おぬわ	ん愛づ	320	んえ
塗わ	Sta	ゐ	おぬわ わぬわ	うぼう	320	34
<sup> </sup>	 3100	われる	わめわ わかね	建场	Jæ í	を
	2				,	-

<b>遂わ</b>	310 °	53 m	おおわ	物物	んごを	Sゑ <sup>°</sup>	を
<b>透わ</b>	333	ろんづ	おねる	物源	んむっかつ	ろゑ <sup>°</sup>	を
<b>透わ</b>	Sab	ろがを	わめる	われを	んを変わ	S₹ <sup>°</sup>	を
<b>透わ</b>	ろれつ	ろ、願	物感	われを	ん <b>淡</b> わ	S₹ <sup>°</sup>	<b>A</b>
<b>透わ</b>	SIR	うを	物感	ねねん	うれる	ろを	われ
<b>透わ</b>	ろを	かれ	物感	ねねん	んを払ろ	ろを	う迷
<b>透わ</b>	ろう	机机	物症	ねおび	うかの	ろを	れ塗
<b>透わ</b>	50D <sup>°</sup>	th	物を	ねおび	を塗ね	383	100 A
<b>透わ</b>	3 <b>8</b> 5	ろんうわ	物症	わかれ `	That	383	<b>A</b> AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
<b>塗</b> わ	ろうわ	State	わぬい	わかれ`	JARE J	333	みた
<b>塗わ</b>	ろ願意	52	わぬい	ねる	んどん	ろあり	を
<b>塗わ</b>	SEL	ろうえ	わぬい	ねる	ん塗込	ろあり	<u>A</u>
遊	Sゑ`	马旋	ねあう	ねる	ん 塗わ	ろ落わ	る
遊	333	わき	わめづ	加貂	んなる	ろ落わ	ん選
愛 ジ	ろきり	ろかわ	ねあ	ねる	れる	ろあわ	25
<i>遠</i> ん	ろを	子的多	おかか <sup>`</sup>	わかろわ	うかうう	ろあわ	わぬ
) Maria	ろもう	35 mi	おゐ <sup>、</sup>	ねるわ	わわ	ろあわ	<u>A</u>
) Maria	343	33 M	おかか <sup>*</sup>	ねぬ	をおう	3 <b>8</b>	<b>1</b> 55
塗り	ろね	ろうか	おかか <sup>`</sup>	ねるわ	をおう	3 <b>8</b>	<b>1</b>

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I IХ́Ц( от	t ∱тд <b>біх∦н</b> ЙЫХ	ѡЦрҨЦй́ЫХ	<del>στ</del> Τί <del>ν</del>	↑பு≹ூப்	- Іфіцрт	<sup>1</sup> т1 <b>/БДО</b> Црт	9↑Џіӿ҄Ҟ҉ӏЦҴ҄҉іѦ҄Ҵӥ҃ЫХ			
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3 an	- স্ক্রহ	初路	物源	ねうう	ん戦る	ろあん	を			
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331D	Share	No.	物源	ねう゛	れのう	350	われ			
3 <b>2</b> 50	ろんゑ	<u>র</u> 🙀	加疮	ねう゛	んちきん	ろをう	を			
う	<u> বিচার</u>	5363	加疮	ねう゛	んねまご	ろを <sup>、</sup>	を			
<b>塗か</b>	<u>3</u>	ろもで	ねむか	ねう゛	うわわ	Z∕æ <sup>™</sup>	<u>A</u>			
塗わ	ろれた	3 <b>≩</b> B	ねむか	<b>ね</b> む`	hh	Shu	を選			
<b>塗わ</b>	<u> ব</u> ্যু	ろうそろ	ねむか	<b>わ</b> ?``	うわわ	343	みき			
<b>塗</b> の	ふうえ	ゑを	ねむ	<b>わか</b> `	hoad	343	<i>反</i> 差			
₹.	加原	55°M	ねむ	<b>ね</b> む``	hth	ろれわ	を強			
うな	われた	thti	hanab `	ねぷろ	化加速	ろれわ	を			
Ů <b>∂</b> D	hare	わた	ねねつ	ねぬろ	んを加え	ろわわ	を			
<b>迷</b> ん	わる意思	ろ <b>遊</b> 気	わわわ	ねぷろ	をき	ろわわ	を			
通り	われた	われん	杨格	ねぷろ	んわわ	ろわわ	62 <b>8</b>			
×	われる	<u>র</u> 🙀	动场	ねぷろ	ん塗ん	ろね	を			
<b>21</b> 60	わわゑ	んろう	わかわ	ねぷろ	<u>う</u> を	ろねゑ	わ塗			
塗わ	われる	わぬろ	ねわ	ねぷろ	Br `	ろを	を			
*	わわえ	机石	ねねり	ねぬろ	んな	ろねを	ん建			
うきん	わ わ あ え	ろんれわ	ねね	ねぷろ	うかわ	ろを	<b>A</b>			
うわ	ねめえ	おめ	ねね	ねぬわ	を習り	Shh	62			
うき	われた	おため	物额	ねぬわ	htatu `	ろわう	ん通			
ううか	わきた	おんち	杨を	ねぬわ	hosh	ろわう	ん通			
ううわ	わきまた	53か	动机	ねぷろ	んねまご	S∕tu`	を選			
うじ	われた	相影	动机	ねぷろ	るる	S∕lu`	62			
うれん	われた気	ろを	ねめ	ねぷろ	んわあん	SA∪`	を選			
うどわ	わうた	ろきを	わわの <sup>~</sup>	ねぷろ	をごわ	ろう	を選			
うる	わった	おわわ	动物	ねぬろ	kniz	333	ん遊			
うざん	检核	ろ塗わ	ねね	ねぷろ	んちわ	333	を整			
うきわ	检读	ろぼう	构级	ねぷろ	knesi	333	を選			
うぼう	われた	ろわ	わるわ	わ <u>ぬ</u> `	hBhB	Sob	を			
うる	わる方気	わわう	ねるわ	ねむ	んえいわ	Sob	を			
うぼり	わる意思	ろきね	ねぬ	ねむ	<b>予</b> 約	ろうわ	を			
うぼう	わわえ	th/B	わわわ	杨沁	たる	ろわ	を			
300	わめえ	ねぬろ	わわわ	ねう゛	んろきを	ろうわ	ん建			
うねか	わめる	招頭	物源	ねう゛	んちまであ	ろうわ	62			
うめ	わる	おもう	杨馥	ねうう	んわぬわ	ろうわ	62			
うた	わめんゑ	ろね	物糖	ねうう	んうきり	ろえ	を整			
うわ	わぼれえ	わる	ねる	ねっか	をきむ	ろうえ	3			
うず	わ遊れ気	杨杨	ත්ත්	ねっか	んれもう	ろを	64			
うえ	わきを見	子小和	ත්ත්	加速	うかるわ	ろを	<u>A</u>			
うわ	われ気	わる <sup>×</sup>	hada <sup>°</sup>	加速	んわろん	ろを	ha a			
うろう	わんゑ	わわう	hhada <sup>°</sup>	物源	化力的	ろを	ん遊			
<u>3</u>	わる意	われる	杨震	ねっか	んろきわ	ろうか	る語			
うきゃ	ね液	われまう	加密	ねっか	handh	ろうか	hæ			

うずづ	ねぎゑ	招速	杨弼 杨	あるる	ろうづ	ん差
うた	dates.	then		Sob has	ろうづ	62 Ka
うわ	るときえ	ත්ති	物類われ	is here "	ろうづ	ん主
ん心う	るとう	ろかわ	ね お わ わ わ わ わ わ わ わ わ わ わ わ わ わ わ わ わ わ	න් චාත්	ろうづ	<u>A</u> A
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んぷわ	るな気	わち	ねるわ ねる	あが を逐ん	35) <sup>*</sup>	h
んうう	るこれを	わ願	物致 物	あるかな	35) <sup>*</sup>	じょ
ht	みるかえ	わねる	物熱 物	施 化加奶	ろう゛	ん塗
んぼう	DETE	わを	物熱 物	ha homb	ろう゛	ん差
んめ	Distance of the second	ろ診わ	物歌 物	ぬうろろか	ろう゛	<u>A</u>
hah	みをゑ	わるか	物熱 物	われを習り	<b>Š</b> ≙`	ん選
んねゑ	るはを気	杨杨	物熱 物	ねりんまれる	<b>Š</b> ☆`	62 Ka
んねっ	るが変	ろを	物類物	ふん んわまう	<b>Š</b> ☆`	<u>A</u>
んをう	る創作系	杨韵	物熱 物	を、んわむ	<b>Š</b> ≙`	68
んあん	る診れ気	ЗŤ	物顯 物	නි කිනි	<b>Š</b> ☆`	をき
んをわ	<b>ANDA</b>	物路	杨蕤 杨	をあ	ろ言ろ	うれ
んをわ	A BEE	ろ簗゛	杨蕤 杨	· 感到 · た 感力	ろ言ろ	を
んそう	<u>A</u> B à	おおり	杨蕤 杨	をわ んねん い	ろぶろ	を塗
んぽん	রাকর	the "	杨蕤 杨	මිත කිම්	ろ言ろ	んな
ん愛わ	夏和爱	机原	杨蓉和	をんろきり	ろ☆ろ	んな
ん塗り	AND	わるわ	动庭物	震 <i>" h</i> わろん	ろぬろ	Ь <b>х</b>
んむ	<u>A</u>	ねむを	杨蕤 物	Sh http://	<u>ろ</u> ☆ろ	58
han	A BOLD	杨楚	动庭物	කෙ රැකිට	ろぬろ	h
hate	A BEAR	わゆう	动庭物	sto knuz	ろぬろ	ジョ
hab	えをえ	杨震	动庭物	<b>愛わ 葱和</b> の	ろぬろ	ジェ
hite	ALER.	根格	动态机	ing handh	ろぬち	<b>ジ</b> 道
んち	<i>ক</i> াক	ねぶ	杨飘扬	あうんえきん	<u></u> 3∞3	hà
h	<i>হ</i> ্য হ	5500	杨飘扬	随着した	ろŵわ	を
んわ	ক্লাক্ষ	わ	物颡 物	et intro	ろ☆わ	hà
wor	কার	ねる	物颡 物	Cab を゛	ろ☆わ	う
hto	をれゑ	わる	物露 材	<i>は</i> わ <i>は</i> わ	ろ☆わ	hite
んもう	を変え	ねった	物熱 物	が ぢ	ろ塗わ	う渡
han	কাৰ	b∰ab	物熱 物	をあが	S≌b	hit
んわ	をわえ	555	物致 物	tab khab	S≌b	を
<i>h</i> ab	হাকে	杨怒	物致 物	ත තා	S≌b	58
hito	を加え	ねぎ	物類の物	か をきを	ろ塗わ	う渡
んそう	をむえ	ろ �� ゛	物致 物	in in the second	S≌b	を塗
hen	を願意	相愛り	杨融 物	をあ	ろ☆わ	62¥
ん変え	645 A	ろ逾ち	ねるわ ねる	1400 Abab	S≌b	を
んぼわ	を変んゑ	わゑん	ねるわ ねる	あるの	ろ塗わ	h ka
んきゃ	を対象	13/10	ねるわ ねる	图" 化加加	S≌b	ん選
hB	を加え	杨苍、	ねるわ ねる	あん を 滚ぬ	ろ塗わ	58
んむ	হিন্দ্র বি	をおび	物源的 物	あ あれね	ろ☆わ	うふ
http	を読え	わぬ	物源的 物	තිං	ろぬわ	3
んな気	を激え	<b>わ</b> ゑ゛	杨露 材	න රාන්ට	ろぬわ	3
んわ	han Ba	ねねる	杨密 杨	れん んれぬを	ろぬわ	3
han	んな	动	秘密 物	振 もうわ <sup>*</sup>	ろぬわ	38
Ь	WEER	われて	物密 物	the khab	ろぬわ	h
をう	んである	物旌	杨柔 打	b hhose	ろぬわ	う
をふん	12012	物類	杨柔 わ	心心 かどう	ろぬわ	3

をえ	64,000	ねる	动物、物效	කින්	ろぬわ	<b>う</b> 渡
をわ	WARE	根を	ねるおわぶわ	を超わ	ろか	5%
をむ	んなた気	杨飘	ねるう わかう	んかわ	ろ泣わ	う
を塗	NORTE	わ <sup>3</sup> ろ	ねねう わかん	hBhB	ろゐゐ	h kh
をうう	hat the second s	ねるう	动动 物藻	をうわ	ろゐゐ	ジ
をか	ん愛れた	根源	物验 物动	を	ろゐゐ	うる
をえ	ん変まえ	<b>热</b> 聚	动旋 物心	を濁ゐ	ろゐゐ	う道
をわ	ん愛え	ねぼう	动猿 わん	khsh	ろきね	う
をうわ	んを見	ねむわ	協动 わぬ	をきわ	ろきね	う道
をう	hietez	ねまう	わるわ わんろ	杨阳	ろぬえ	58
をん	化的原	ねめ	ねぬわ わをう	をむわ	ろぬえ	う道
を検索	WARE	机名	动动力物态	んちおわ	ろぬえ	h
をわ	んる意	反物	物語われ	をきわ	<u> এ</u> জু	うえ
をわ	NOTE	物を	ねね わを	を塗う	ろ☆を	3
をん	hit	極め	动物、物象	をあわ	ろ☆を	34
をもう	んずえ	わを	动物 物动	をめ	ろ☆を	he
をあ	心液	杨柔、	动症物影	を思わ	ろぬん	<b>ご</b> 渡
を読	ん塗蒸	招额	动猿物。	を遡り	ろきん	hg
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をあわ	うれた	ねっか	わかわ わかわ	を感わ	ろう	<b>ジ</b> 道
をを	JARR.	物查	动场 物场	をむ	ろ塗う	<b>ジ</b> 密
を変わ	JARE	たわ	ねるか われん	あっ	ろう	54
を願い	JEE	<b>按</b> 梁 <sup>*</sup>	动动 物动	を思わ	 3≙``	通
を愛わ	3	拍签	动症 物奶	ත්ත		64 101
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をわ	Jaka C	おき	おかを わか	杨庭	われを	6
<b>を</b> わ		わどう	おいわわか	hold	われ	102 102
<b>を</b> わ	<u>う</u> 運ゑ	11222		るあ	われ あれ で	ん遊
をわ	う 酒 ゑ	1725	おかわ わら	んわぶを	1240 1240	3
をめ		13250	招勤 わぬ	14 <u>2</u> 2	1240 われ゛	が進
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を成	JAM SA	わえ わえ	物源物物	んわらわ	わ <u>あ</u>	シュ ん選
を反	うぬゑ	があわ	おんわ わるみ	heste	わるわ	102 102
をわ		が遊	初遊 加差	を塗わ	わどわ	
をわ	3.000 3.000	13.200 ろを約	物類なり	-2 <b>≈</b> 37 1-35	わるわ	<u>_</u>
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をわ	ALE .	おかぬわ て ごろご		<u>ණ</u> වූවි 30 ක	わるか	う
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をわ	ATT .	ろをあん - ろのマ	おかか わかう	んわれわ	わる゛ いる、	<b>A</b> S
をわ	No.	ため	おころ われえ	ත්වූවි	わる゛	う <u>%</u> ニャ
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をわ	No. 3	わかん い ろ <del>な</del> い		έæn) ta ∞t	われた	
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をわ		をわ	初始 われる	を設定	わ <sup>3</sup> D 、	کۆ
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をわ	گڼ ۲	ろをわわ	わん、招売	んねる	わた	<b>夏</b> 日 一
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をか	No.	たわ	わきわ おかわ	෯	わね	う運
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をわ	জনহ •	お願わ	わえめ おきを	んどん	われわ	64
をわ	STR.	物怒	物面、扬扬	る意思	われわ	ん遊
をわ		物格	わたを招き	hhab "	わます	が
をわ	<b>B</b>	根乾	わぬわ 招を	ねる	われた	3
をわ	জনহ ম	han h	ත්ත තිබ්ට	んわめを	わめを	hile
ক্ষিক্স	Notes and the second se	根藏	初初初	を勤	われ	
をわ		根因	かわれる一般	んかわ	われづ	
をわ	100 A	ね	物物がわ	んねきを	わるう	62
をめう		物意	物かれる	をかず	わぬ <u>、</u>	
をわ	Note .	the	物症 招氣	khab "	わえ	64
をわ	No.	たる	かわ 招助	をを	われ	ジュ
をわ	MER.	杨灿	われる おろおう	をきわ	わえる	<b>ジ</b> 済
をわ	遊れゑ	極う	ねずね	を知	わゑわ	う
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をあ	Server and the server	根板	わるわ おろうわ	んわえる	わえる	
をあう	জুনুর জন্ম	zhrö	わる 招助	うった	わえつ	ත්ර
を柔	WEEK.	ねかう	物都都路	hosto	わた	6
を愛わ	<b>釣</b> ゑ	おわわ	动物 招助	hhab "	わえ	h
を愛わ	NA NA	わゆわ	物糖素	んねきを	わまた	<b>3</b> 4
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を動	· · · · · · · · · · · · · · · · · · ·	わ塗ね	物都多物	んる塗わ	わえん	×
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をを	MES.	1316	<b>超ぶう 招わ</b> ゛	うねり	わえつ	を
をあわ	う液	йд»́	超き 招わ、	うかねっ	わゑ゛	われ
を通り	<u>J</u>	Mag Mag	තික තින	文的	わゑ゛	わぶ
を読	ううえん	かな	ත්ර ත්ර	石城	わゑ゛	う道
をあ	<u>3</u>	わ格	ත⊇්බ ත්විණ	んわあん	わを	64
をおう	う運気	扬速	超が超め	KNAB	わを	ん建
をわ	JAR	th	超う゛招わ゛	を鬱わ	わるろ	3
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