Food Security Production Challenges in Indonesia as Impact of Global Climate Change

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Abstract— *Global food availability, including national as well as local, is highly dependent on the natural resources that will affect crop production. Although there is rain, soil temperatures and conditions have formed a natural system that will support agricultural efforts, but this state is unstable and always changes according to atmospheric conditions in an integrated manner. Human beings on certain boundaries can intervene with the natural resources.*

Climate (generally a combination of rain, temperature, and sunlight) is the most important growth factor in crop production in the field. Any change in climatic conditions will have far-reaching effects on global food production.

Global climate change, excessive land and land exploitation, inaccurate land management, in its time will have an impact on the food production and availability of a region. Knowing well the of nature characteristics, then anticipating the impact that will arise and determine the ways of handling it, is a series of business and activities that must be done to achieve food security.

To anticipate climate change and its impacts on crop production, a broad outline can be made by considering the following physical technic aspects: 1) adjusting cropping patterns; 2) increasing the area of forest cover and catchment areas; 3) application of land and crop management technology. Some application of land and crop management technologies include: organic farming, implementation of Surjan system, food diversification, large tree planting, water pond production, etc.

The policies that need to be taken as a solution in anticipating the impact of global climate change are 1) the preparation and stipulation of special food agriculture scenarios, including the zoning of production potential and zonation of climate risk (drought, flood, landslide, etc.) with the updating of data every year; 2) reducing the conversion of agricultural land (food); 3) incentives for farmers; 4) changing the consumption pattern of the people, from the consumption of rice to alternative staple foods; 5) subsidies and protection of food farming; 6) climate monitoring and prediction (early rainy season, long growing period, and potential water availability; 7) Revitalization of watershed (DAS) functions; 8) Multiply the artificial water absorption area.

Keywords— Climate Change, Food Security, Land and Crop Management, Watershed.

I. INTRODUCTION

Increased concentrations of greenhouse gases in the atmosphere due to human activities around of the world, causing increased radiation trapped in the atmosphere. The impact is the occurrence of an increase in average temperatures across the earth's surface, referred to as global warming.

Increasing the average temperature of the Earth's surface causes changes in other climatic elements, such as rising sea temperatures, increased evaporation in the air, and changing patterns of rainfall and air pressure that eventually change the pattern of world climate. This event became known as global climate change.

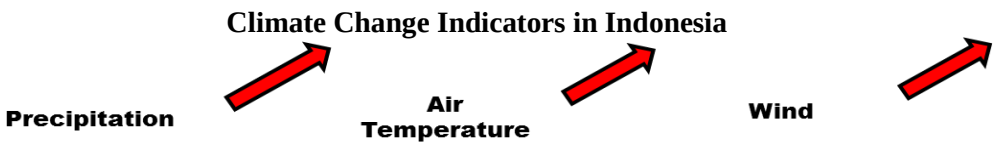

TABLE 1
CLIMATE CHANGE INDICATORS IN INDONESIA

No.	Climate Elements	Phenomenon	Impact
1.	Precipitation	Longer dry season	Water shortage, crop failure
		Shorter rainy season with high intensity	Flood, erosion, landslide, crop failure
2.	Air Temperature	The temperature is hotter	Increased evaporation, impaired growth
3.	Wind	Strong local winds at the time of the rain	Disrupting plant growth

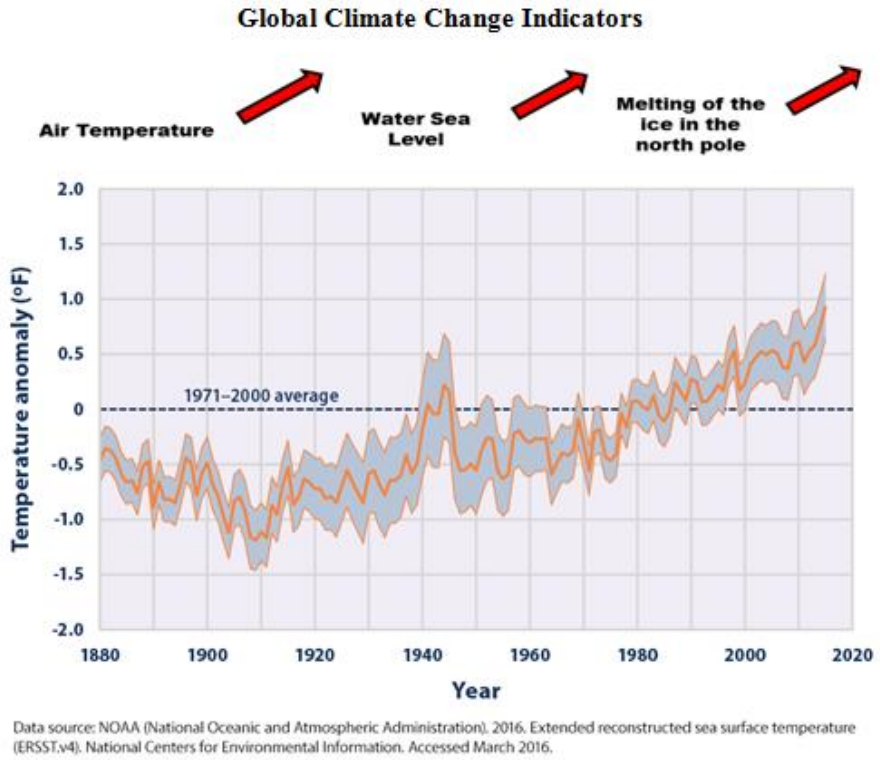

FIGURE 1. AVERAGE GLOBAL SEA SURFACE TEMPERATURE, 1880-2015

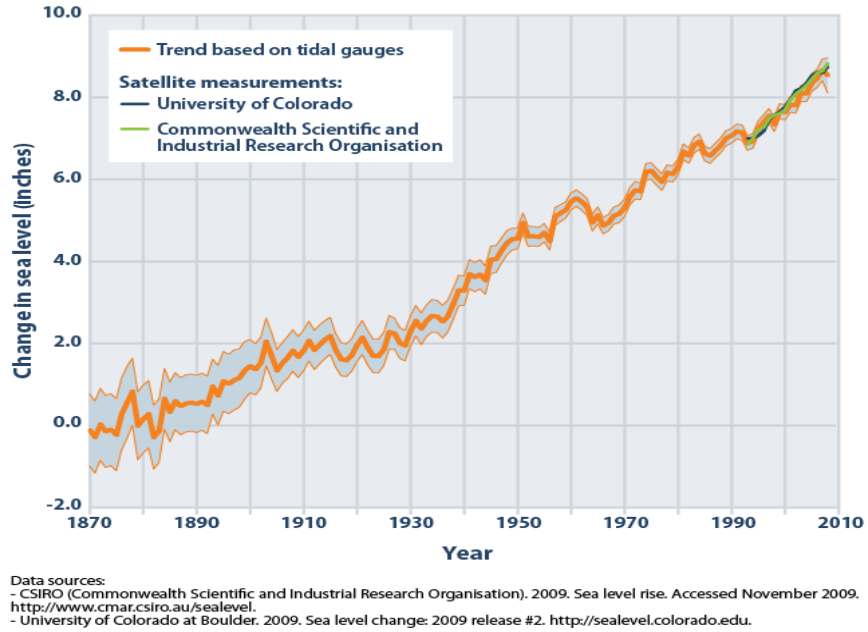

FIGURE 2. TRENDS IN GLOBAL AVERAGE ABSOLUTE SEA LEVEL, 1870-2008

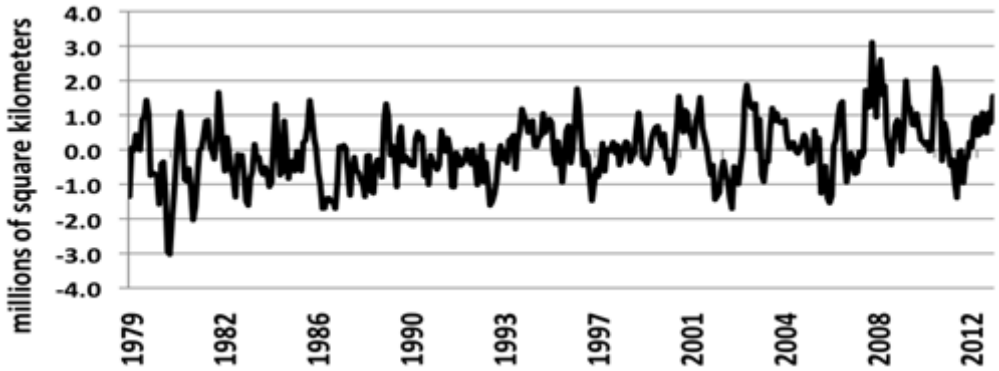

FIGURE 3. ANTARTIC SEA ICE EXTENT ANOMALIES, 1979-2012 (UNIVERSITY OF ILLINOIS)

II. DATA AND FACT

At the regional micro-scale in Indonesia, several climate elements that undergo changes include wind, temperature, and precipitation (Table 2).

Some studies of average historical data, air temperatures in Indonesia increased by 0.3 ºC per year since 1900. in the 1990s was the warmest decade and 1998 was the warmest year, 1 ºC above the 1961-1990 average . Increased temperatures occur throughout the season. Rainfall is reduced by 2 to 3% especially in December-February. In most parts of Indonesia rainfall is affected by El-Nino, major droughts occur in El-Nino years 1982/1983, 1986/1987, and 1997/1998.

TABLE 2
THE CHANGING OF CLIMATE ELEMENTS IN INDONESIA

Location	Year	The Changing Element per Year		
		Temperature	Precipitation (dry season)	Precipitation (wet season)
Data Source 1				
Jakarta	1916-1987	0.03**	*	*
Jakarta	1951-1987	*	- 0.1 %	10 % **
Bogor	1951-1987	*	- 1.1 % **	0.3 %
*Bogor	1976-1987	0.05**	*	*
Bogor	1980-1998	0.14**	-2.0 % **	4.6 % **
Data Source 2				
Indonesia		Meningkat 0.3 ºC	Hujan tahunan menurun 2-3 %	

Data Source 1: Hidayati (1990), Hidayati, Abdullah, and Suharsono (1999).
Data Source 2: Hulme and Sheard (1999), Boer and Faqih (2004).

TABLE 3
THE CHANGING OF MONTHLY RAINFALL ON NORMAL RAINFALL (IN %, AVERAGE VALUE 1970-1997 IN SOME PROVINCE)

Island	1970			1997		
	Oct-Mar or Nov-Apr	Apr-Sept or May-Oct	Annual	Oct-Mar or Nov-Apr	Apr-Sept or May-Oct	Annual
Sumatera	-35	-47	-38	-21	-32	-24
Java	-34	-80	-41	-11	-85	-23
Bali/NTT	-26	-82	-31	-26	-75	-32
Kalimantan	-33	-57	-40	-5	-36	-16
Sulawesi	-28	-67	-39	-35	-33	-30
Maluku/Ambon	-13	-53	-40	-5	-27	-20
Indonesia	-32	-62	-38	-19	-47	-24

Data Source: Irawan, 2002

III. MATERIALS AND METHOD

The methodology used in this research is the Sytematic Review Method. As with the methodology of individual research, in principle, systematic review research begins by making a systematic review research protocol and the next stage of

conducting systematic review research. Sequentially, the process of systematic review research is shown in Table 4. Analog with general research methodology, where there are quantitative and qualitative methods, then in systematic review there are also quantitative methods and qualitative methods.

Quantitative method of systematic review is used to synthesize the results of research with quantitative approach. For example, Randomized Control Trials (RCTs), Cohort Study, Case-Control Study, or prevalence studies. The statistical approach in synthesizing the results of quantitative research is called "meta-analysis". By definition, meta-analysis is a technique of aggregating data to obtain statistical power in identifying causal relationships between risk factors or treatment with an outcome (Perry & Hammond, 2002). Meanwhile, qualitative approach in systematic review is used to synthesize qualitative descriptive research results. The method of synthesizing (summarizing) the results of qualitative research is called "meta-synthesis". By definition, meta-synthesis is a technique of integrating data to gain new theories and concepts or deeper and more thorough understanding levels (Perry & Hammond, 2002).

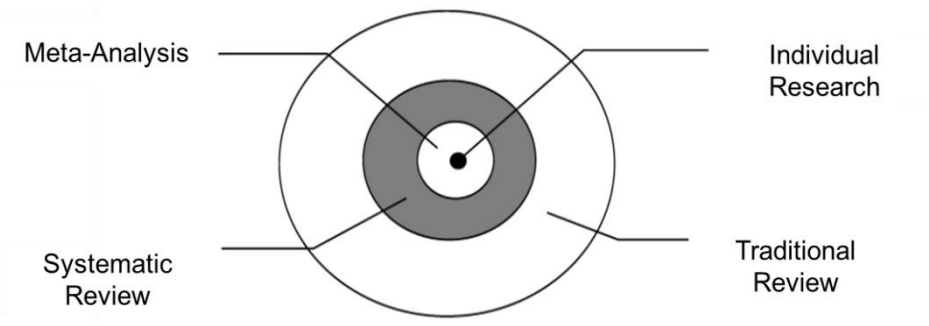

FIGURE 4. POSITION OF SYSTEMATIC REVIEW METHODS IN ANOTHER RESEARCH METHODS

TABLE 4
SEQUENCE OF SYSTEMATIC REVIEW PROCESS (PERRY & HAMMOND, 2002)

No.	Sequence of Process	Objective
1.	Identify questions research	Make a transformation climate change problems into question research
2.	Develop protocol research systematic review	Giving guides in doing systematic review
3.	Set location Data-base results research as search area	Provide restrictions search area against the results of the study which is relevant
4.	Selection of results relevant research	Collect the results relevant research with questions research
5.	Select good quality results of research	Conducting exclusion and inclusion of research to be entered in systematic review based on quality
6.	Data extraction from individual studies	Perform data extraction from individual studies to get the findings importance
7.	Result synthesis by method Meta-analysis (if allow), or narrative method (if impossible)	Conducting synthesis of results with metaanalysis techniques (forest plot) or narrative techniques (metasintesis)
8.	Presentation of results	Write down the results research in the document reports systematic results review

IV. RESULTS AND DISCUSSION

4.1 Impact of Climate Change

4.1.1 Floods and Drought

Indonesia there have been 46 major drought events, 30 of which occurred in the period 1844-1960 (for 117 years), and the remaining 16 events in the period 1961-2006 (only for 46 years). While the floods, became a common occurrence almost every rainy season in various provinces (Ministry of Environment Republic of Indonesia, 2007). During the period of 2001-2004 there have been 530 flood events in various regions in Indonesia.

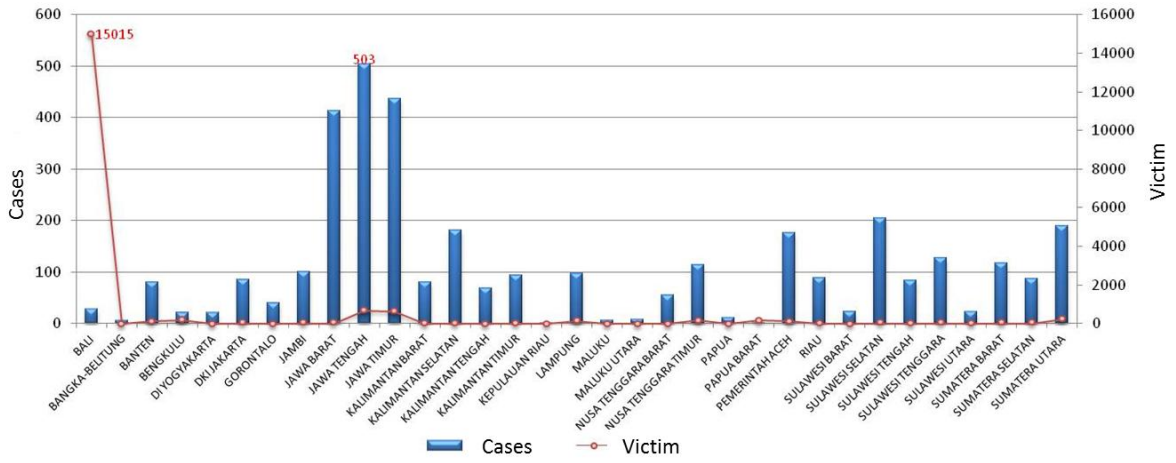

FIGURE 5. NUMBER OF FLOOD CASES AND VICTIMS DEATHS PER PROVINCE 1822-2011 (DATA SOURCE BNPB, 2012)

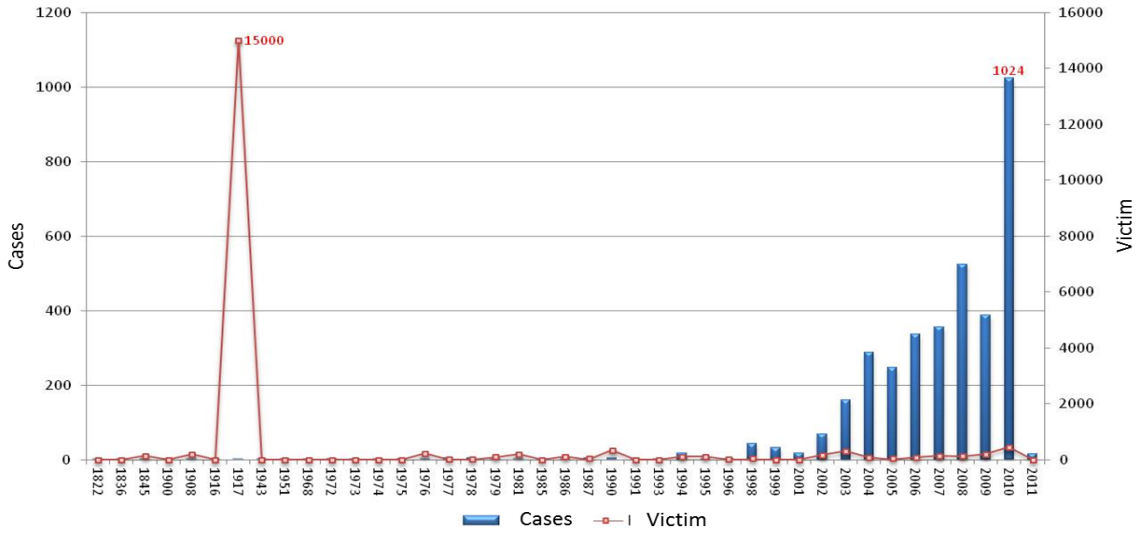

FIGURE 6. NUMBER OF FLOOD CASES AND VICTIMS DEATHS PER YEAR 1822-2011, (DATA SOURCE BNPB, 2012)

TABLE 5
SITUATION OF DROUGHT AND HARVEST FAILURE IN INDONESIA

Year	Drought Impact (Decreasing Production in Hectares)	Harvest Failure in Hectares
1990s		
1994	489,178	150,319
1995	18,462	3,385
1996	48,490	11,485
Total	**556,130**	**165,162**
2000s		
2001	145,545	11,344
2002	298,678	30,694
2003	430,258	82,690
Total	**874,481**	**124,728**

Data Source : Indonesian Department of Agriculture, 2007.

TABLE 6
CONDITION OF WATERSHED (DAS) IN JAVA ISLAND

No.	Province	Broodstock	DAS Square (Km^2)	Min	Max	Qmax/Qmin	Condition
1.	Banten	S. Ciujung	1,563	1.0	1,880	1,880	Critical
2.	West Java	S. Cisadane	820	1.0	1,150	1,150	Critical
		S. Ciliwung	158	0.1	390	3,900	Critical
		S. Citarum	1,675	2.0	370	185	Critical
		S. Cimanuk	1,966	1.0	710	710	Critical
		S. Citanduy	1,416	0.1	1,250	12,500	Critical
3.	Central Java	K. Pemali	856	0.1	850	8,500	Critical
		K. Serang	98	0.1	100	1000	Critical
		K. Juana	46	0.1	110	1,100	Critical
		B. Solo	3,207	2.0	9,990	4,495	Critical
		K. Serayu	723	3.0	1,580	527	Critical
4.	DIY	K. Progo	423	0.1	900	9,000	Critical
		K. Opak	30	0.1	10	100	Critical
5.	East Java	K. Brantas	7,112	10.0	3,180	316	Critical
		K. Sampean	612	0.1	850	8,500	Critical
		K. Pekalen	163	0.1	200	2000	Critical

Data Source : DBPSDA-PU, 2009.

4.2.2 Agriculture Production (Paddy)

Notes in the Indonesian Meteorological and Geophysical Agency show that the dry periods Indonesia has experienced are 1991, 1993, 1994, 1997, 2000, and 2001, while the times of excess water are 1992, 1996, 1999, and possibly 2002 (Table 5). This fact can be used to predict and simultaneously inform not only when the right planting, but also the type of plant that best fits the condition. This will greatly assist food security efforts and reduce the risk of crop failure.

TABLE 7
AREA OF RICE CROPS AFFECTED BY FLOODS, DROUGHT, AND HARVEST FAILURE (PUSO) IN HECTARES (1988-1997)

Year	Remark	Flood	Drought	Puso
1987	El-Nino	***	430,170	***
1988	La-Nina	130,375	87,373	44,049
1989	Normal	96,540	36,143	15,290
1990	Normal	66,901	54,125	19,163
1991	El-Nino	38,006	867,997	198,054
1992	Normal	50,360	42,409	16,882
1993	Normal	78,480	66,992	47,259
1994	El-Nino	132,975	544,422	194,025
1995	La-Nina	218,144	28,580	51,571
1996	Normal	107,385	59,560	50,649
1997	El-Nino	58,974	504,021	102,254

Data Source : Jasis and Karama, 1999; Yusmin, 2000.

4.2 Projection of Food Production

The effect of climate change on crop production depends on factors, namely: 1) the magnitude of changes in influencing climate variables; and 2) plant adaptability. According to Rosenzwig and Iglesias (IPCC, 1996), there will be a decline in some food commodities in some countries as follows (Table 8). The most influential aspects of climate elements to production are air temperatures and rain.

TABLE 8
PREDICTION OF FOOD PRODUCTION IN SOME COUNTRIES

Countries	Impact to Agriculture Production
Indonesia	Rice -2.5 %; Soybean -2.3 %; Maize -40 %
Malaysia	Rice -22 % to -12 %; Rubber -30 % to -3 %
UK	Land Productivity (+5 % to +15 %)
USA	Wheat -14 % to -2 %; Maize -29 % to -15 %; rice -23 %

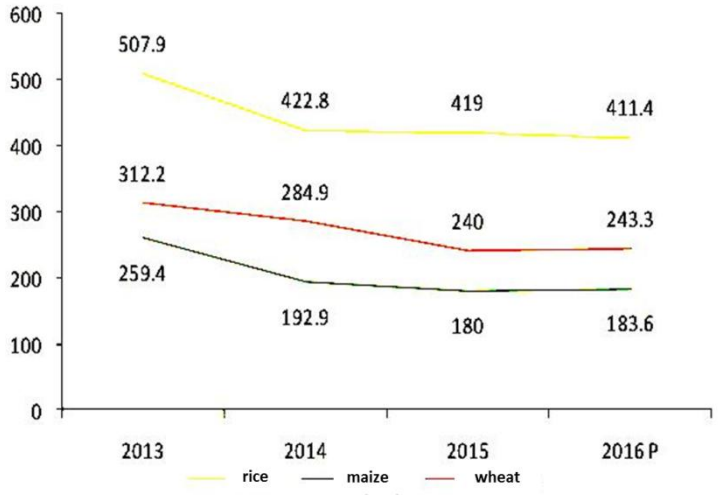

FIGURE 7. PROJECTION OF GLOBAL FOOD PRODUCTION DECREASE (DATA SOURCE IGICO ADVISORY, 2015)

4.3 Adaptation and Mitigation

To anticipate climate change and its impact on crop production, the outline can be done by considering the following physical technic aspects:

1. Adjusting cropping patterns;
2. Increasing the area of forest cover and catchment areas;
3. Application of land and crop management technology. Some application of land and crop management technologies include: organic farming, implementation of Surjan system, food diversification, large tree planting, water pond production, etc.

V. CONCLUSION

The policies that need to be taken as a solution in anticipating the impact of global climate change are:

1. The preparation and stipulation of special food agriculture scenarios, including the zoning of production potential and zonation of climate risk (drought, flood, landslide, etc.) with the updating of data every year;
2. Reducing the conversion of agricultural land (food);
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4. Changing the consumption pattern of the people, from the consumption of rice to alternative staple foods;
5. Subsidies and protection of food farming;
6. Climate monitoring and prediction (early rainy season, long growing period, and potential water availability.
7. Revitalization of watershed (DAS) functions.
8. Multiply the artificial water absorption area.

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