

Influences of the Weather on Mental Status in Okayama and Tottori, Japan

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Keywords: suicide, meteorological factor, regression analysis

1. Introduction

Weather sensitivity (Wetterfähigkeit)

Anyone is weather-reacting. According to a survey (von Mackensen and Höppe, 2001) to 55% of population is afflicted by weather condition in Germany. The results show, 19.2% of the asked think that their health in strong measure on the weather depends.

Purpose of this Study

We got started this study because Yamato is also a 'weather-sensitive' person. In this thesis we aim to find relationships between the weather condition (temperature, relative humidity, air pressure, and sunshine duration) and human emotions (suicides, crimes, and traffic accidents) based on statistics.

2. Materials and Methods

We will compare climate of 2 southwestern Japanese cities-Okayama and Tottori-, because Okayama is my hometown.

Tottori (35°29.2' N, 134°14.2' E; 3507km²) lies on the north side of Okayama (34°39.6' N, 133°55.0' E; 7009km²) in Japan. They are relative warm and humid Japanese cities. But they have a little different climate by reason of the Sea of Japan and big mountains.

Okayama has a population of about 1955 thousand and Tottori 604 thousand.

Here are tables of weather of Okayama and Tottori. They show the relative humidity in Tottori is relatively higher than Okayama throughout the years. What we should say is that the sunshine duration of

Tottori in winters is only a half time long in Okayama. (See the Table in next page.)

Data Source

We have got monthly data (January 2001 - December 2006 per month) on:

- suicides from Ministry of Health, Labour and Welfare of Japan and Okayama and Tottori Prefecture
- crimes and traffic accidents from National Police Agency and Okayama and Tottori Prefectural Police
- meteorological factors (temperature, relative humidity, air pressure, sunshine duration, and weather) from Japan Meteorological Agency
- population from Statistics Bureau, Ministry of Internal Affairs and Communications

We wanted to gather daily data because it is better to verify a hypothesis -correlation between the human emotion and the weather-, but I could not get them on account of privacy problems, especially on the field of suicide deaths.

3.5. Hypothesis

Suicides

We think there is a relationship of suicides especially with sunshine duration. In my opinion where the sun shines short, there are more suicide deaths. In the respect that person gets depressed when it is cloudy or rainy. So I will show the distribution maps of sunshine duration and suicide deaths in Japan. As the maps show, my hypothesis might be right.

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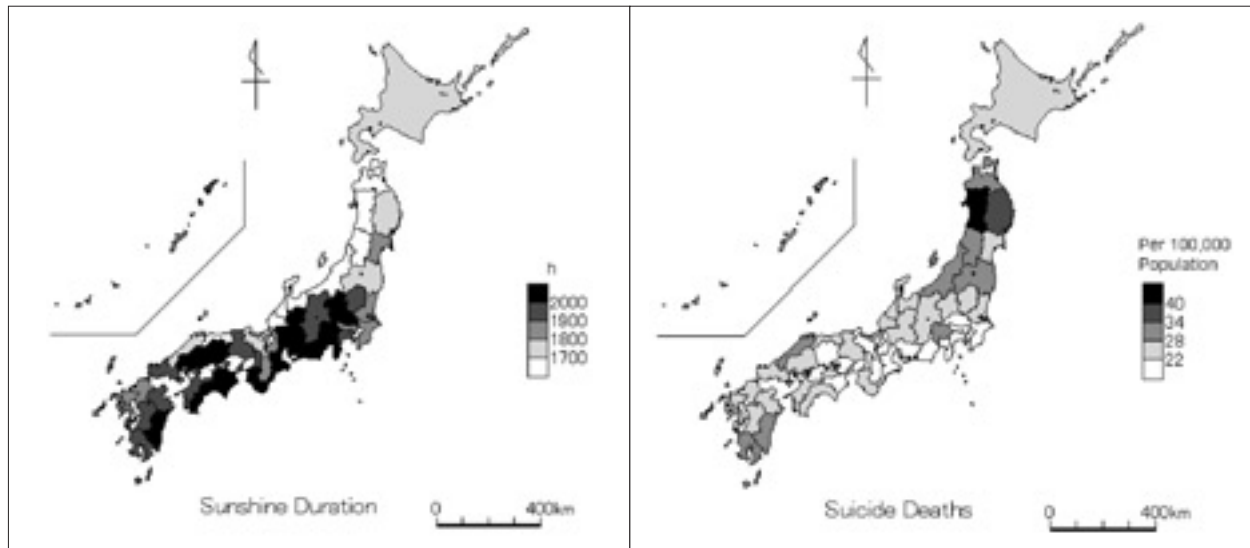


Fig.3-7: Sunshine duration (Japan Meteorological Agency, Normals 1970 - 2000) and suicides (Ministry of Health, Labour and Welfare of Japan, 2006) in Japan.

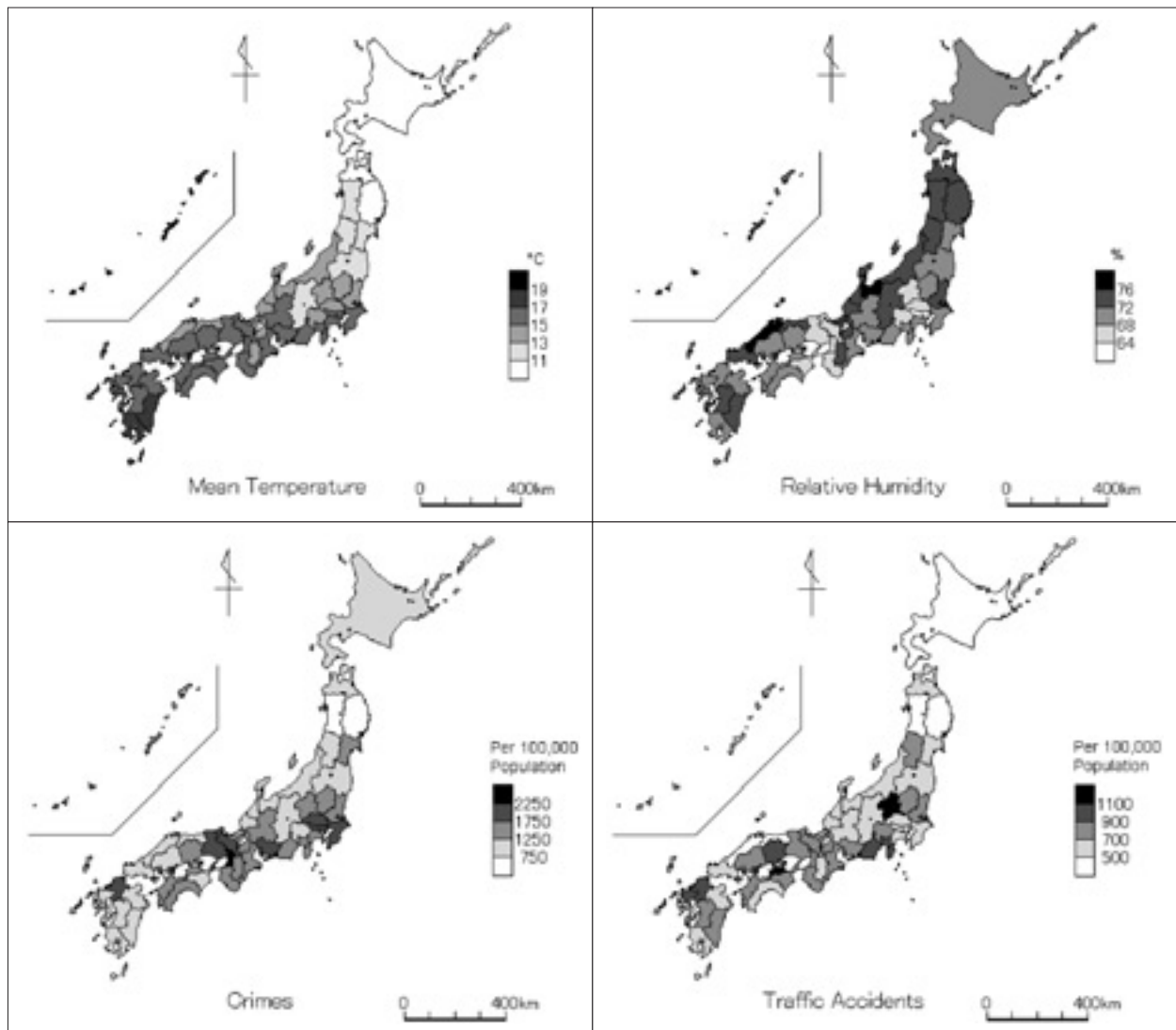


Fig.3-8: Mean temperature and relative humidity (Japan Meteorological Agency, Normals 1970 - 2000) and crimes and traffic accidents (National Police Agency of Japan, 2006) in Japan.

Crimes and Traffic Accidents

On crimes and traffic accidents there are relationships with temperature and relative humidity. Crimes and traffic accidents occur oftener at high temperature and humidity, We think. That is because person gets impatient when it is hot and humid. Here are distribution maps of mean temperature, relative humidity, crimes, and traffic accidents. We can not exactly mention that crimes and traffic accidents relate with the temperature and relative humidity.

Methods

First we made graphs from the statistics and gave careful consideration to a tendency. Then we did regression analyses with excel and got correlation coefficients of them.

3. Results

3.1. Trends of Statistical Data

3.1.1. Meteorological Data

(See also tables in page XX.)

We have got the meteorological monthly data on sunshine duration, mean temperature, and air pressure from January 2001 to December 2006 (six years = 72 months) and normals from 1971 to 2000 and seasonally statistics from Spring 2001 to Winter 2005 (5 years = 20 seasons, spring: March to May, summer: June to August, autumn: September to November, winter: December to February) of Okayama and Tottori, and the data of all Japanese cities from Japan Meteorological Agency.

Mean Temperature

As mentioned in the chapter 3, the monthly and seasonally mean temperature in is high in July and August (summer) and low in December to February (winter). There are no different trends between Tottori and Okayama, or each year.

Relative Humidity

Relative humidity in % is relatively high in summer and low in spring, but there are some differences

at each year. Comparing of Okayama and Tottori, it is higher in Tottori throughout the year, especially in winter because of snow. In June we have the rainy season and we can see the relative humidity is high.

Sunshine Duration

Sunshine duration in h is long in spring to summer, and particularly short in winter. In Tottori it is almost a half time of it in Okayama in winter. Because of the rainy season the sunshine duration is short in June. There are different trends at each year. In 2003 there is no great difference in each season.

Air Pressure

Air pressure in hPa is low in June to August (summer) and high in winter. No difference appears between both cities and in each year.

The weather in Okayama and in Tottori is shown in the Table 4-1. It is similar in spring, summer, and autumn, but in winter is changeable in Tottori and it has more snowfalls. Okayama has apparently more sunny days than Tottori. So we say in Japan, Okayama is sunny land. In Okayama it dose not often snow. In spring (March to May) it is sunny or cloudy in the both cities. They have more cloudy days in summer (June to August). In autumn (September to November) there are many sunny days. In Okayama it is almost fair weather, on the other hand it snows sometimes in Tottori in winter (December to February).

3.1.2. Emotional Data

- Suicides, Crimes, and Traffic Accidents -

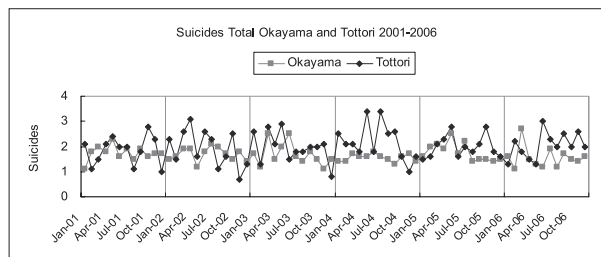
To easily compare the two cities - Okayama and Tottori -, we convert these all data into per 100 thousand population.

Statistics of Suicides

We have got the monthly data on suicides in 2001 - 2006 from Ministry of Health, Labour and Welfare (MHLW) of Japan and Okayama and Tottori Prefecture. Honestly said, we wanted get them from the police, because the statistics from the Police Agency covers total population (including foreigners in Japan), while MHLW covers only Japanese living in Japan. But the Police Agency has disadvantage for me or for my study too. It counts numbers based

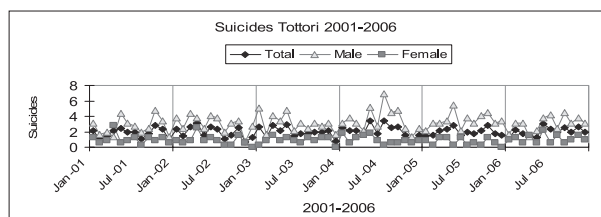
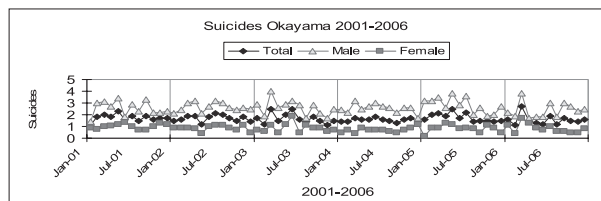
on the time of discovery of corps (more precisely "recognition"), while MHLW dose so based on the time of death and the living place ("Overview of Suicides" by the National Police Agency). In Okayama Prefectural Police dose not count and have any monthly data on suicides.

In Japan more 30000 people commit suicide and they are 3 times more than deaths by traffic accidents (Ministry of Health, Labour and Welfare of Japan, 2003).



It appears that suicide death rates in Tottori are higher than in Okayama. We think it because of the shorter sunshine duration in Tottori. But at the present time we can not mention in which season they have the peak.

In the figures below, we can see the suicides by sexual. In both cities the suicide death rates by male are almost always higher than by female. It is because the men are psychic weaker than the women or there are the causes of suicides, not only meteorological factors but also social, financial factors etc., we think.

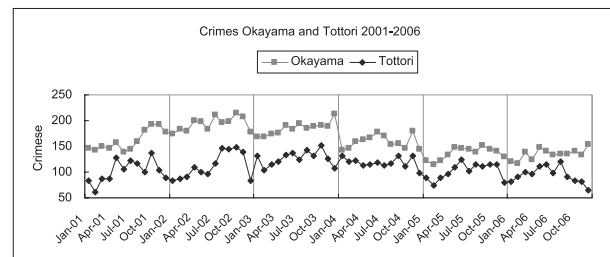


Data on Crimes

There are many kinds of crimes, e.g. felonious

offenses, violent offenses, larceny offenses, intellectual offenses, moral offenses, and other offenses. We have got the statistics of total number cases known to the police, total cases cleared up, and total arrestees and all kinds of the crimes in 2001 - 2006 from the Okayama and Tottori Prefectural Police. In this thesis we will take only the total number cases known to the police, because we think total cases cleared up and total arrestees are not related with the weather condition or human emotions. But there is an interest survey that the rates of total cleared up in Tottori (more than 50%) are higher than in Okayama (ca. 30%). Person says offenders escape to a northern city and will be arrested because it is a small country.

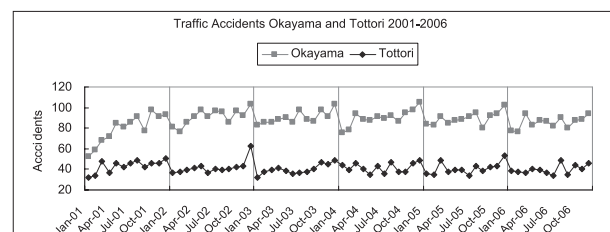
Throughout the year total cases of crimes are higher in Okayama. In winter are the crimes relative less than in summer, but we can not say exactly.



Data on Traffic Accidents

We have got the data on traffic accidents in 2001 - 2006 and partly by the weather 1997 - 2006 from the Okayama and Tottori Prefectural Police.

The traffic accidents have the peak in December in the almost all year. In Okayama the traffic accidents occur more than 2 times often in Tottori. Okayama has 5th many traffic accidents and Tottori 44th of all 47 Japanese cities. we heard, in the respect that people in Okayama are more aggressive than those in Tottori because of the climate.



In the Table 4-2 traffic accidents on a sunny, cloudy, rainy, foggy, or snowy day are shown. Each value is divided by the days of the weather (see Table 3-1 and 4-1). We can see that many traffic accidents mostly happen on sunny days. In our opinion, people

would be more careful on cloudy or rainy days, therefore it happens less. In Okayama there are more traffic accidents in snowy days than in Tottori. That is because, we think, Okayama does not often snow.

3.2. Results of Regression Analysis

Table 4-3: Correlation coefficient R from the data

		72 Months	Year 01	Year 02	Year 03	Year 04	Year 05	Year 06	Season
	Sample Size N	72	12	12	12	12	12	12	20
Okayama									
Suicides	4 Parameters	0.443	0.409	0.609	0.685	0.632	0.599	0.717	0.695
	2 Parameters	0.249	0.341	0.577	0.500	0.315	0.301	0.231	0.595
	Temperature	0.077	0.242	0.448	0.106	0.211	- 0.003	- 0.214	0.325
	Rel. Humidity	- 0.193	- 0.177	- 0.222	- 0.349	- 0.074	- 0.283	0.004	- 0.329
	Sunshine Dur.	0.283	0.372	0.594	0.344	0.508	0.393	- 0.057	0.556
	Air Pressure	- 0.248	- 0.301	- 0.446	- 0.333	- 0.244	- 0.296	- 0.017	- 0.530
Crimes	4 Parameters	0.381	0.757	0.675	0.657	0.664	0.895	0.673	0.353
	2 Parameters	0.279	0.597	0.547	0.348	0.507	0.853	0.359	0.336
	Temperature	0.193	- 0.005	0.547	0.330	0.489	0.842	0.314	0.260
	Rel. Humidity	0.257	0.579	0.145	0.274	0.164	0.165	0.276	0.298
	Sunshine Dur.	0.073	0.003	0.249	0.224	0.328	0.363	0.378	- 0.021
	Air Pressure	- 0.075	0.344	- 0.362	- 0.146	- 0.411	- 0.637	- 0.149	- 0.162
Traff.Acc.	4 Parameters	0.659	0.887	0.650	0.335	0.714	0.562	0.699	0.698
	2 Parameters	0.415	0.728	0.582	0.096	0.506	0.235	0.124	0.635
	Temperature	0.220	0.531	0.400	0.068	0.138	- 0.091	0.114	0.360
	Rel. Humidity	0.407	0.610	0.519	0.093	0.480	0.171	- 0.005	0.622
	Sunshine Dur.	0.133	0.500	0.039	0.095	- 0.116	0.051	0.448	- 0.145
	Air Pressure	- 0.058	- 0.204	- 0.282	0.064	0.127	0.045	- 0.093	- 0.163
Tottori									
Suicides	4 Parameters	0.327	0.253	0.514	0.593	0.700	0.771	0.500	0.759
	2 Parameters	0.292	0.226	0.388	0.405	0.495	0.350	0.495	0.598
	Temperature	0.222	0.196	0.095	- 0.041	0.427	0.288	0.388	0.222
	Rel. Humidity	- 0.198	- 0.111	- 0.387	- 0.396	- 0.195	- 0.252	0.321	- 0.580
	Sunshine Dur.	0.327	0.228	0.325	0.470	0.360	0.547	0.152	0.634
	Air Pressure	- 0.213	- 0.152	- 0.232	0.091	- 0.627	- 0.059	- 0.266	- 0.205
Crimes	4 Parameters	0.542	0.768	0.829	0.774	0.320	0.890	0.864	0.740
	2 Parameters	0.502	0.741	0.585	0.624	0.145	0.810	0.737	0.574
	Temperature	0.491	0.739	0.585	0.608	- 0.094	0.809	0.613	0.571
	Rel. Humidity	- 0.123	0.059	- 0.191	0.050	0.098	- 0.194	- 0.387	- 0.022
	Sunshine Dur.	0.373	0.620	0.402	0.576	- 0.225	0.637	0.664	0.285
	Air Pressure	- 0.339	- 0.532	- 0.306	- 0.479	0.162	- 0.575	- 0.790	- 0.343
Traff.Acc.	4 Parameters	0.354	0.636	0.641	0.749	0.404	0.489	0.860	0.548
	2 Parameters	0.104	0.434	0.402	0.230	0.391	0.317	0.306	0.272
	Temperature	- 0.079	0.410	- 0.268	- 0.067	- 0.370	- 0.282	0.085	- 0.271
	Rel. Humidity	0.069	0.147	0.372	- 0.230	0.078	0.198	- 0.291	0.057
	Sunshine Dur.	0.025	0.361	- 0.457	0.084	- 0.252	- 0.139	0.471	- 0.061
	Air Pressure	0.216	- 0.254	0.449	0.397	0.389	0.278	0.166	0.323

* 4 parameters: temp., rel. humidity, sunshine duration, air pressure; 2 parameters: temp., rel. humidity

With excel calculated correlative coefficients R are shown on the Table 4-3 and what significant at the 5% risk are written in boldface and what in random relationship are in italic. The acceptable coefficients are more than $R = 0.576$, 0.444 , and 0.233 at the 5% significance level for the sample size $N = 12$, 20 , and 72 .

Many correlation coefficients are significant by four distinct parameters (temperature, relative humidity, sunshine duration, and air pressure) or two parameters (temperature and relative humidity). But it is difficult to say which meteorological factor(s) or which weather condition(s) is/are strongly correlated with the human emotions by suicide death, crimes, and traffic accidents at the present.

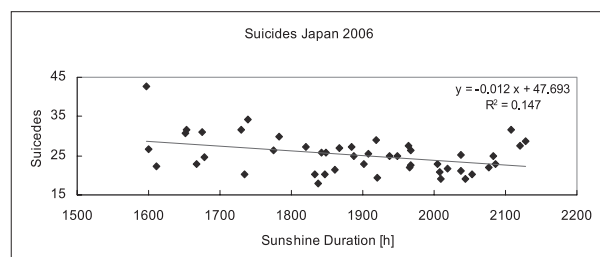
We can also see that the suicide deaths are positive associated with the mean temperature and the sunshine duration and negative with relative humidity and the air pressure in both cities. The crimes are positive correlated with the mean temperature, relative humidity and sunshine duration in Okayama, positive with the temperature and sunshine duration in Tottori, and negative with the air pressure in both cities. The traffic accidents are positive correlated with the temperature, the relative humidity and sunshine duration and negative with air pressure in Okayama, and positive with the relative humidity and air pressure and negative with the temperature and sunshine duration in Tottori.

3.3. Meteorology and Suicides

According to the results on the Table 4-3, multiple regressions of the suicides with four parameters (temperature, relative humidity, sunshine duration, and air pressure) are positive and relatively high in both cities (Okayama and Tottori). But we can not say what it means because of its complexity. With two parameters (temperature and relative humidity) are shown relatively strong positive correlations. Thus we might mention that a person could suicide himself in the hot (or warm) and humid weather. We can see also that there is the relationship between suicides and sunshine duration especially in Okayama.

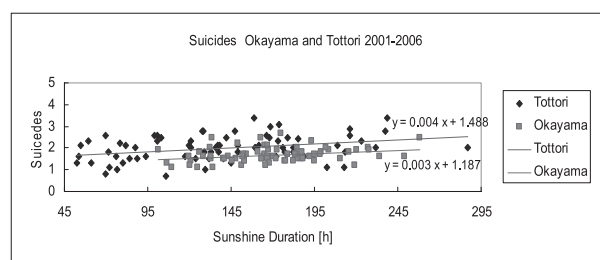
In general the correlations of suicides with the relative humidity and the air pressure are negative, while suicide deaths are positive correlated with the mean temperature and the sunshine duration.

We thought the suicide death rates increase with decreasing sunshine duration. And it is shown in the association between the suicides and sunshine duration in all 47 Japanese cities (See figure below).



The correlation coefficient: $R = -0.383$ (More than 0.289 is significant at $N = 47$ cities.)

But in our results, as we mentioned before, we can see the positive correlation. It means a man can commit suicides while sun shines. In Japan person also says that suicides increase in the springs, especially under continuation of warm sunny days. According to a statistic (Eto, 1990), those who commit suicide increase by durations of sunshine long.



Suicides and Temperature

Now we enlarge the results with figures.

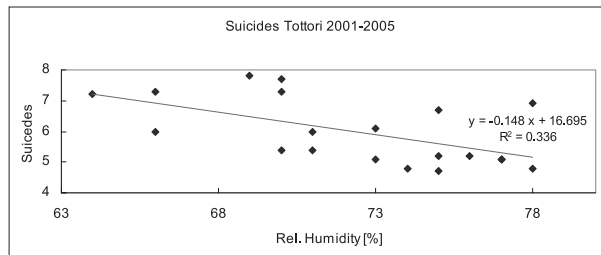
The relationship of suicides with the mean temperature alone is not so high in our results. We were honestly surprised, but we can also image that it could be indifferent to someone who will commit suicide whether it is hot or cold.

Suicides and Relative Humidity

As we said, there is the negative correlation between suicides and relative humidity. It means that

a person could be murdered by himself. According to the results however, the relation is not so strong.

In the figure below we can see a sample correlation of suicides with the relative humidity. They are seasonally data, these mean spring, summer, autumn, and winter from 2001 to 2005. The value of R^2 is also relatively high.

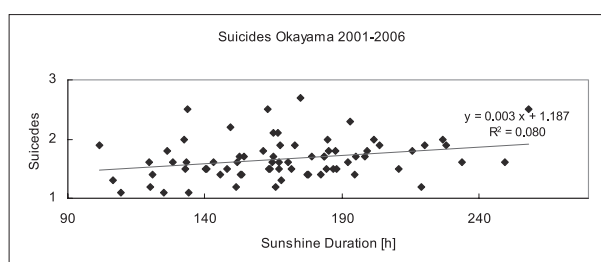


The correlation coefficient: $R = -0.580$ (More than 0.444 is significant at $N = 20$ seasons.)

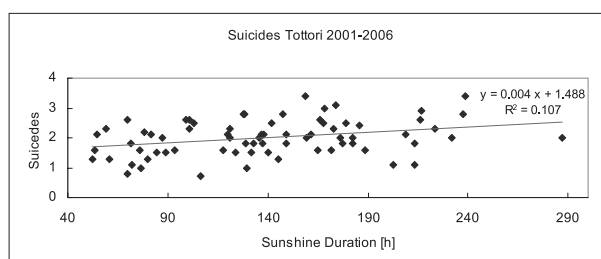
Suicides and Sunshine Duration

We can see the relative strong and positive relationship of suicides with the sunshine duration. According to the results, we could say that the correlation is a little stronger in Tottori than in Okayama. That is because, as we mentioned, there are more suicides in Tottori and duration of the sunshine in winter is a half in Okayama.

The two figures below are monthly data of suicides from 2001 to 2006.

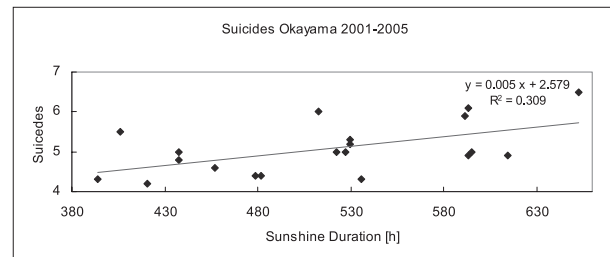


The correlation coefficient: $R = +0.283$ (More than 0.233 is significant at $N = 72$ months)

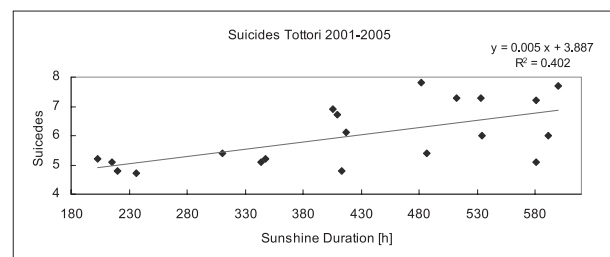


The correlation coefficient: $R = +0.327$

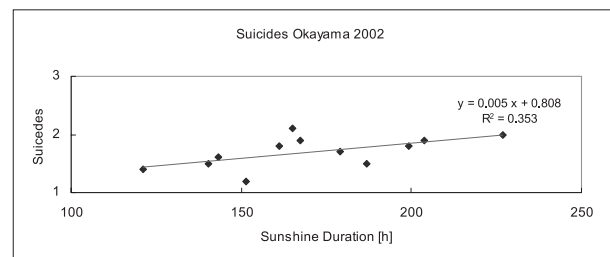
In the next two figures are given seasonally data from 2001 to 2005. We can see the correlation coefficients and also the values of R^2 are relatively high.



The correlation coefficient: $R = +0.556$ (More than 0.444 is significant at $N = 20$ seasons in both cities.)



The correlation coefficient: $R = +0.634$



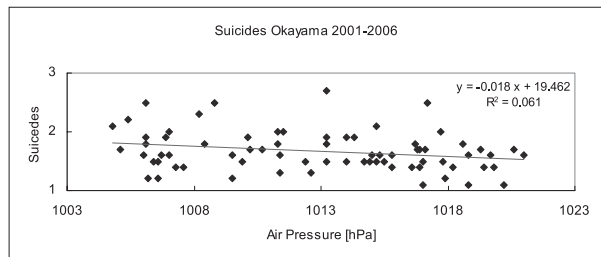
The correlation coefficient: $R = +0.594$ (More than 0.576 is significant at $N = 12$ months.)

We can see in the figure on the preceding page the monthly data in 2002 in Okayama. There is a weak correlation between the suicides and the sunshine duration. We might say the value of R^2 is relatively high.

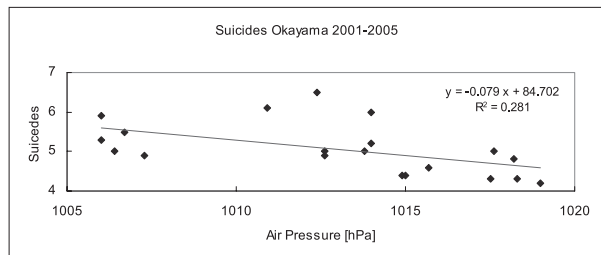
Suicides and Air Pressure

From the Table 4-3 we can read that the monthly and seasonally relationship in Okayama is stronger compared with that in Tottori from 2001 to 2006.

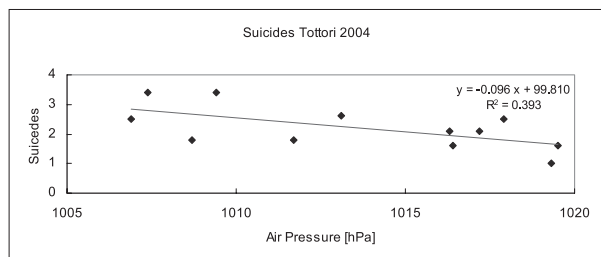
Here in the figures are shown that suicides are negative correlated with the air pressure, as mentioned above. In 2004 we had a strong correlation in Tottori. The value of R^2 is also high.



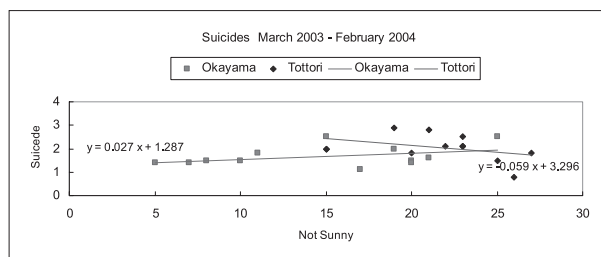
The correlation coefficient: $R = -0.248$ (More than 0.233 is significant at $N = 72$ months.)



The correlation coefficient: $R = -0.530$ (More than 0.444 is significant at $N = 20$ seasons.)



The correlation coefficient: $R = -0.627$ (More than 0.576 is significant at $N = 12$ months.)



In both cities we can see positive $R = 0.391$ (Okayama) and negative $R = -0.400$ (Tottori). The values are relatively high, we think. It means that in Okayama people commit suicides on not-sunny days and in Tottori on sunny days.

3.4. Meteorology and Crimes

When we see the Table 4-3 we can know that the crimes are negative correlated with the relative humidity in Tottori and with the air pressure in both

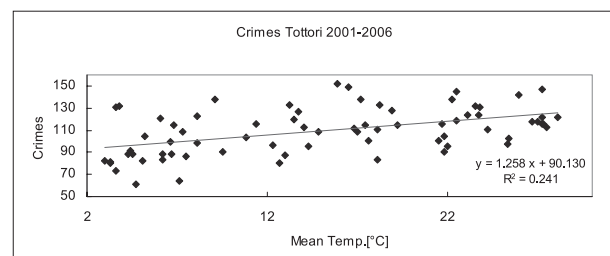
cities. With four parameters (temperature, relative humidity, sunshine duration, and air pressure) and with two parameters (temperature and relative humidity) are shown relatively strong positive relationships. The correlations with the mean temperature and the sunshine duration are especially in Tottori very significant.

Our hypothesis was that there is a relationship of crimes with temperature and relative humidity. According to the results we can mention that it might be right.

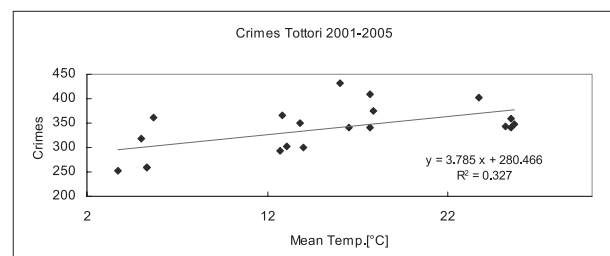
Now we will see the results in detail.

Crimes and Mean Temperature

As mentioned above, the correlation between crimes and the mean temperature is positive. We can see stronger correlation of Tottori than that of Okayama. A Policeman in Tottori meant there are fewer (less) crimes in winter because it is very cold and the ground is covered with snow. In Okayama is not so colder than Tottori and there is mostly not covered with snow.



The correlation coefficient: $R = +0.491$ (More than 0.233 is significant at $N = 72$ months.)

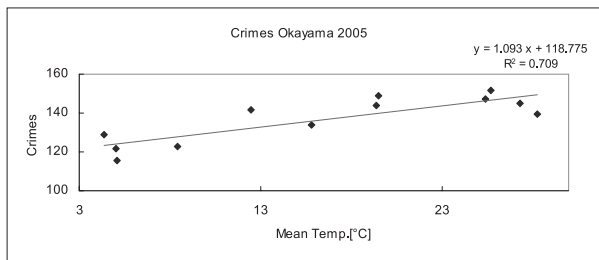


The correlation coefficient: $R = +0.571$ (More than 0.444 is significant at $N = 20$ seasons.)

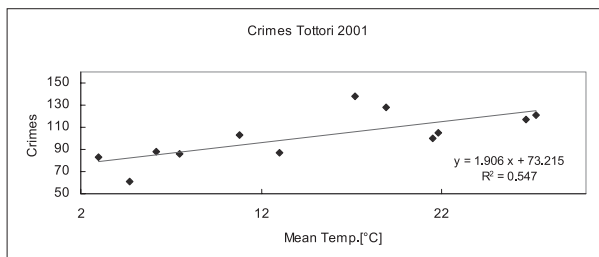
We can see in the figures below the significant results in each year, and the values R^2 of those are also higher than the others.

In Okayama the correlation was significant only in

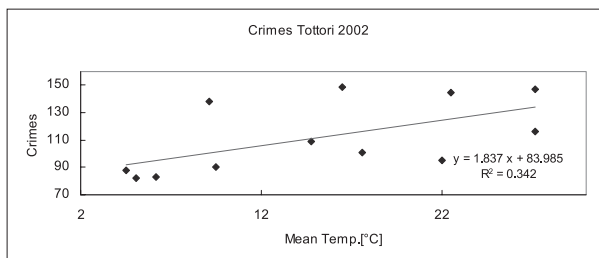
2005. But we think it is the best result of all.



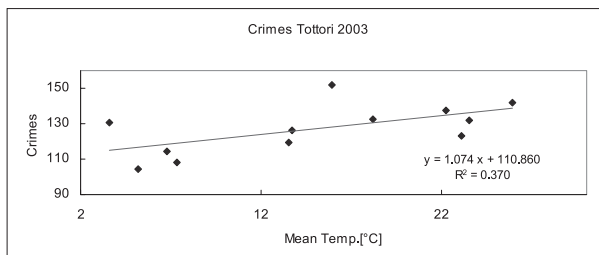
The correlation coefficient: $R = +0.842$ (More than 0.576 is significant at $N = 12$ months.)



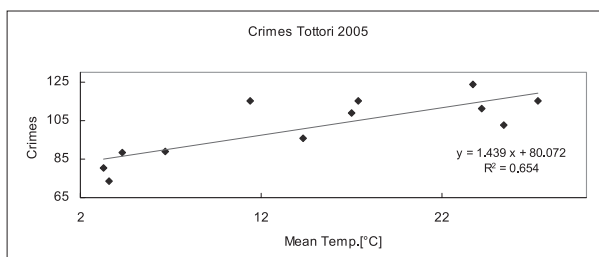
The correlation coefficient: $R = +0.739$



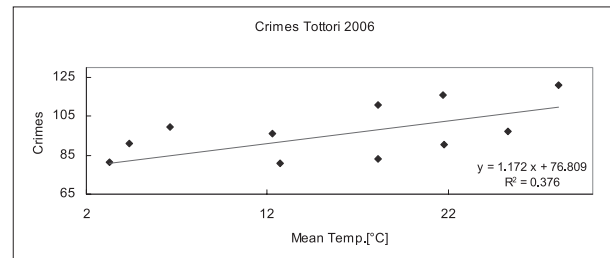
The correlation coefficient: $R = +0.585$



The correlation coefficient: $R = +0.608$



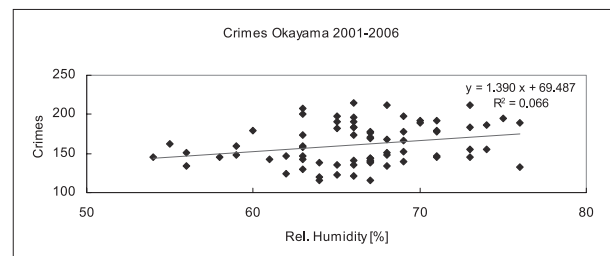
The correlation coefficient: $R = +0.809$



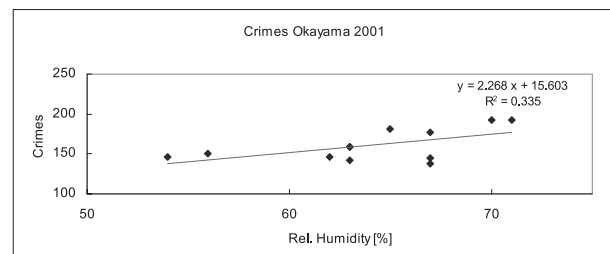
The correlation coefficient: $R = +0.613$

Crimes and Relative Humidity

The results in the Table 4-3 (see page XX) are shown that crimes are generally positive correlated with the relative humidity in Okayama and negative in Tottori. But the relationship is not so strong. Especially in Tottori we can see no significant results.



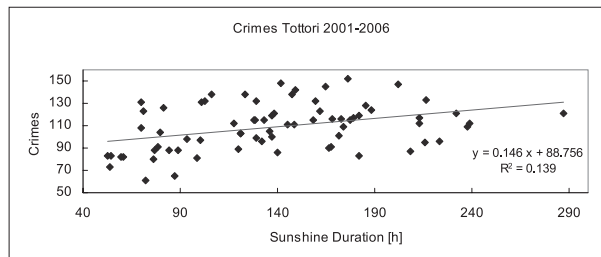
The correlation coefficient: $R = +0.257$ (more than 0.233 is significant at $N = 72$ months)



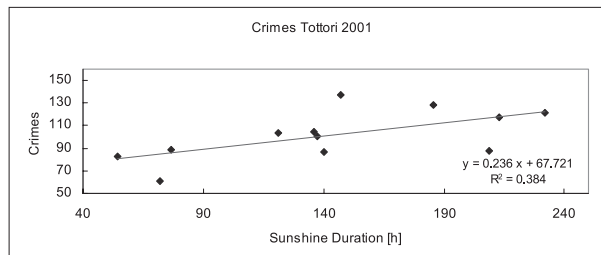
The correlation coefficient: $R = +0.579$ (More than 0.576 is significant at $N = 12$ months.)

Crimes and Sunshine Duration

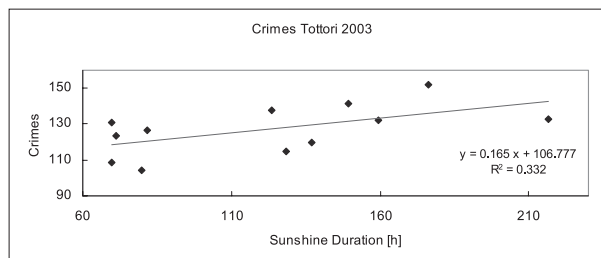
In opposite we can see the correlation of crimes with the sunshine duration only in Tottori. We can mention why. In any case it is not strong by the long periods (72 months and 20 seasons).



The correlation coefficient: $R = +0.373$ (More than 0.233 is significant at $N = 72$ months.)

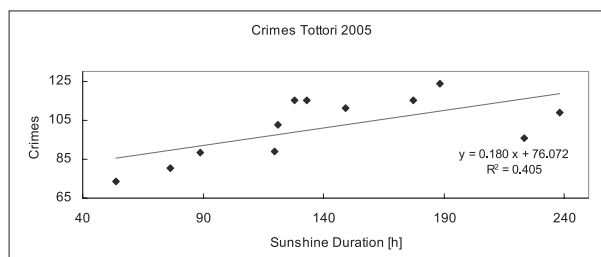


The correlation coefficient: $R = +0.620$ (More than 0.576 is significant at $N = 12$ months.)

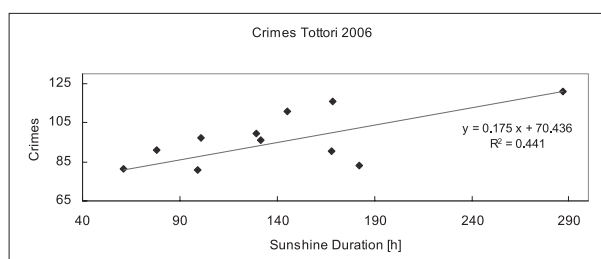


The correlation coefficient: $R = +0.576$

In 2005 and 2006 we can see the higher correlation coefficients and R^2 .



The correlation coefficient: $R = +0.637$

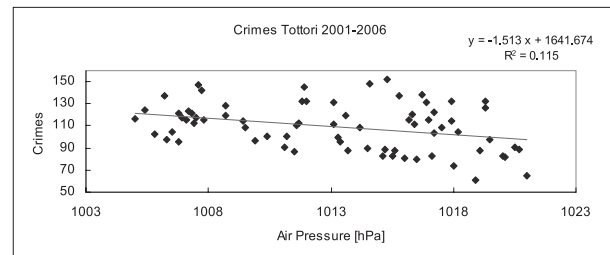


The correlation coefficient: $R = +0.664$

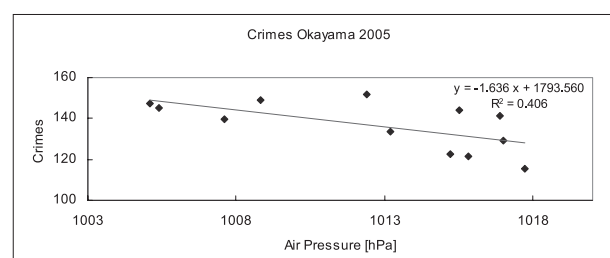
Crimes and Air Pressure

With the Air Pressure we can read the negative relationship of crimes. A person often commits crimes under the low pressure. It sometimes means it is not a fine weather.

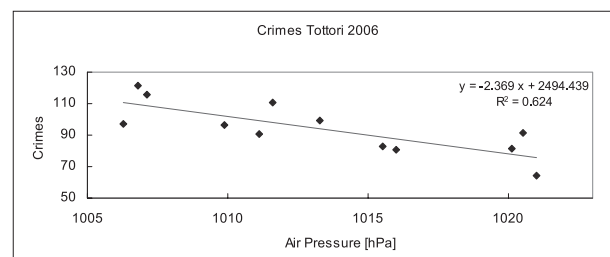
In general the results are not significant. But the figure of 2005 in Okayama and that of 2006 in Tottori show the good correlation between crimes and the air pressure.



The correlation coefficient: $R = -0.339$ (More than 0.233 is significant at $N = 72$ months.)



The correlation coefficient: $R = -0.637$ (More than 0.576 is significant at $N = 12$ months.)



The correlation coefficient: $R = -0.790$

3.5. Meteorology and Traffic Accidents

In the Table 4-3 (see page XX) it is shown that traffic accidents are not particularly associated with the meteorological factors. Only with four or two parameters we can see the correlation of traffic accidents. These are surprising results for us.

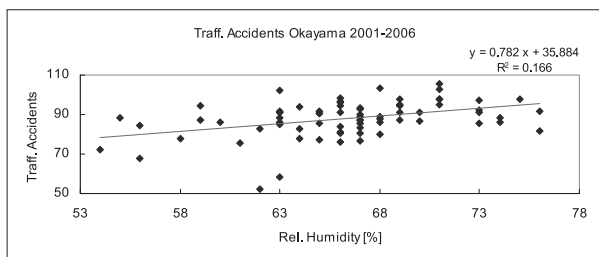
The relationships between traffic accidents and the individual factors (the mean temperature, the relative

humidity, the sunshine duration, and the air pressure) are weak, and we do not exactly know whether the association is positive or negative.

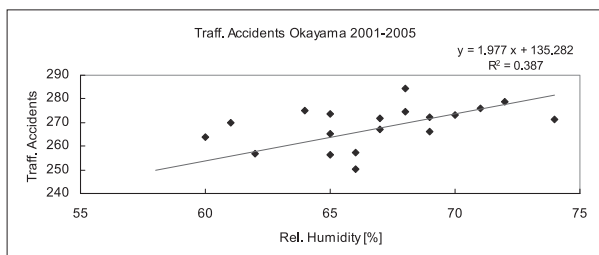
There are a few significant results with the relative humidity in Okayama.

Traffic Accidents and Relative Humidity

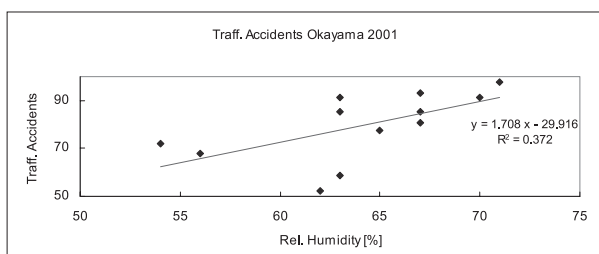
In the next figures we can read the positive correlation between traffic accidents and the relative humidity. The correlations coefficients of the long-term periods (72 months and 20 seasons) show are relatively high. Maybe we could mention that the values of R^2 are also high in 20 seasons and the year 2001.



The correlation coefficient: $R = +0.407$ (More than 0.233 is significant at $N = 72$ months.)



The correlation coefficient: $R = +0.622$ (More than 0.444 is significant at $N = 20$ seasons.)



The correlation coefficient: $R = +0.610$ (More than 0.576 is significant at $N = 12$ months.)

4. Conclusion

Heretofore we have tried to analyze and consider the influences of the weather on the human emotions. We really wondered that there are relatively big influences of the weather. There are certainly not only the weather influences, but also the social influences, e.g. human relations, financial problems, etc. In our opinion, the weather is one of the stressers that cause the suicide deaths, crimes, and traffic accidents.

Temperature, relative humidity, and sunshine durations are meteorological factors on the feeling of warm or cold. Human bodies are controlled by the homeostasis that keeps the temperature constant. When the body temperature rises or sinks 2 °C, human can become sick. Compare with the human body the meteorological environments surrounded us change very fast. Then the homeostasis controls our body, but the changes of the weather could be stress for us.

Human bodies have seasonal changes. On autonomic nervous system parasympathetic tense in summer and sympathetic in winter. Human bodies are responsive to stimulations as reflex though the nervous system. When the stimulations continue it change physiological reaction of internal secretion and then habituation. On an uncomfortable day a person could be emotional instable because the change of the system is big. People who have argy, problems with autonomic nervous system, internal secretion, or psychological problem can excessively react to stimulations. Then their autonomic nervous system or hormones can not smoothly respond to it and their condition or mind are harmful influenced by meteorological changes. That is why seasonal disease and meteorological disease exist. It is closely related between health and psychology. On healthy people also the system can change with meteorological changes.

5. Problems of the Survey

We took the statistics of two cities in Japan. But we

also wanted to compare with Germany because we study there.

The data were too scarce for the survey. We could send out questionnaires to people or we could be the reagent of the survey myself.

We wanted to have the daily statistics of suicides, because it could be deeply analyzed the human emotions with the weather conditions. But in Japan the data are not released because of privacy problems.

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Influences of the Weather on Mental Status in Okayama and Tottori, Japan

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keywords: suicide, meteorological factor, regression analysis